MEDDELELSER OM GRØNLAND
UDGIVNE AF
KOMMISSIONEN FOR VIDENSKABELIGE UNDERSØGELSER I GRØNLAND
BD. 133 · NR. 2

GEOLOGISK EXPEDITION TIL ØSTGRØNLAND 1936–38
UNDER LEDELSE AF LAUGE KOCH

NOTES ON THE GEOLOGICAL MAP OF CANNING LAND (EAST GREENLAND)

BY

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WITH 19 FIGURES IN THE TEXT
AND 6 PLATES

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1948

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PREFACE

As a member of the Danish expeditions to East Greenland 1931—34 and 1936—38 under the leadership of Dr. LAUGE KOCH I made geological investigations in the Devonian formation. In August 1936, after finishing my summer work in Hudson Land, I had the opportunity to visit the most southerly exposures of the Devonian series in East Greenland, on the peninsula of Canning Land by Davy Sund.

At the end of August of that year the coastal waters at the entrance to Davy Sund were entirely free of ice, so it was possible to go by motorboat from the station Ella Ø to Nathorst Fjord without being troubled by drift ice. On August 29th the wireless operator at the station on Ella Ø, Mr. A. DE LEMOS, a trained motorman, took us to the working field, and on September 6th we were fetched by the expedition ship "Gustav Holm" in Nathorst Fjord to return to Iceland.

On account of the limited time at our disposal the working programme was concentrated on some few points. Dr. G. SÄVE-SÖDERBERGH and his assistants devoted themselves to stratigraphical investigations and the collecting of fossils, while I directed my attention to the tectonics, principally to the structural position of the Devonian deposits and their relation to the overlying and underlying rocks. I crossed the peninsula of Canning Land in some places, measured some sections through the coastal rocks, and visited two localities on the south side of the nearby Wegener Halvø. Only part of the important localities could be visited and directly mapped in the field. In some areas my observations were accordingly rather incomplete, this applies especially to the eastern part of Canning Land; I only observed the Triassic area to the west, near Nordenskjöld Fjæld, from a distance. Similarly, owing to lack of time it was impossible to trace and map the various systems of eruptive dykes. Moreover the geological mapping suffered from the lack of accurate topographical maps. The maps, sections, and stereograms accompanying the present work accordingly require to be supplemented in many details.

The geology of Canning Land is at present known in its main features; the reader is referred to the recent papers by A. NOE-NYGAARD

(1937), G. SÄVE-SÖDERBERGH (1937), H. BÜTLER (1937), H. STAUBER (1942), and K. KLEIBER (1944). The principal object of the present work is to sum up the descriptions hitherto published, to supplement them on some points, and on the basis of the different formations represented on the peninsula of Canning Land to point out the importance of this small area for the interpretation of the older tectonic phenomena in the region around Davy Sund. The graphic representation hitherto appeared, which is in some degree insufficient, will be supplemented by sections and stereograms. The bedding of the pre-Cambrian, Palæozoic, and Mesozoic formations of Canning Land is so well exposed within a limited area that it is worth while to represent them graphically.

The leader of the expedition, Dr. LAUGE KOCH, always courteously placed the equipment required for the investigations in the field at my disposal, and I always had the opportunity to discuss the working problems with him. Again and again I could draw on his great experience and his knowledge of the geology of Greenland. On this account I am greatly indebted to him. Professor G. SÄVE-SÖDERBERGH I thank for good cooperation and for inciting discussions on the ship and at the camp fires. My former wintering companion, A. DE LEMOS, who served as motorman during our field work in Nathorst Fjord, rendered me extremely good assistance. Discussions with a great number of the geologists who in the years before the war were at work in East Greenland, were very inspiring to me. Mention should especially be made of Professors H. BACKLUND, E. H. KRANCK, and E. WEGMANN. Dr. H. STAUBER, Zürich, has kindly lent to me a large number of his photographs of Wegener Halvø.

Schaffhausen, June 1946. H. BÜTLER.

I. INTRODUCTION

At the southern entrance to Davy Sund, in about 72° N. lat., 22° W. long., three small fjords, Carlsberg, Nathorst, and Fleming Fjords, cut from the outer coast into the country in a southwesterly direction. Between them lie Canning Land and Wegener Halvø, south of them, along the outer coast, the long and narrow Liverpool Land; Jameson Land in the southwest and Scoresby Land in the northwest form the hinterland (cf. fig. 1). In many summers Canning Land and Wegener Halvø are inaccessible from the sea. Often the winter ice in the surrounding fjords does not melt, or sea ice that has drifted in blocks the coasts. On this account the first geographic and geological maps of the two peninsulas did not appear till late. The surveying was made in the year 1900 on the Danish "Carlsbergfondets Expedition" under the leadership of N. HARTZ: the topographical map was published on a scale of 1:460,000, by J. P. KOCH (1902), the geological map by O. NORDENSKJÖLD (1907). Shortly before the regions just north thereof had been cursorily investigated by A. G. NATHORST (1900), while the first geological knowledge of the more easily accessible Liverpool Land and Jameson Land dates back to WM. SCORESBY (1823) and R. JAMESON. However, systematic geological investigations in the field within these two areas were also commenced on RYDER's expedition in 1891 and 1892 by BAY (1895) and HARTZ (1896) and continued in 1899 by NATHORST (1901) and in 1900 by NORDENSKJÖLD (1907) and HARTZ (1902). Since the year 1926, when LAUGE KOCH gave new impetus to the geological investigations in East Greenland, a greater number of papers dealing with the regions around Nathorst Fjord and Fleming Fjord have appeared. The geological problems relative to these areas have been subject to lively discussion and the history of the geological investigation of Canning Land and its surroundings will therefore be dealt with at some length in the following pages.

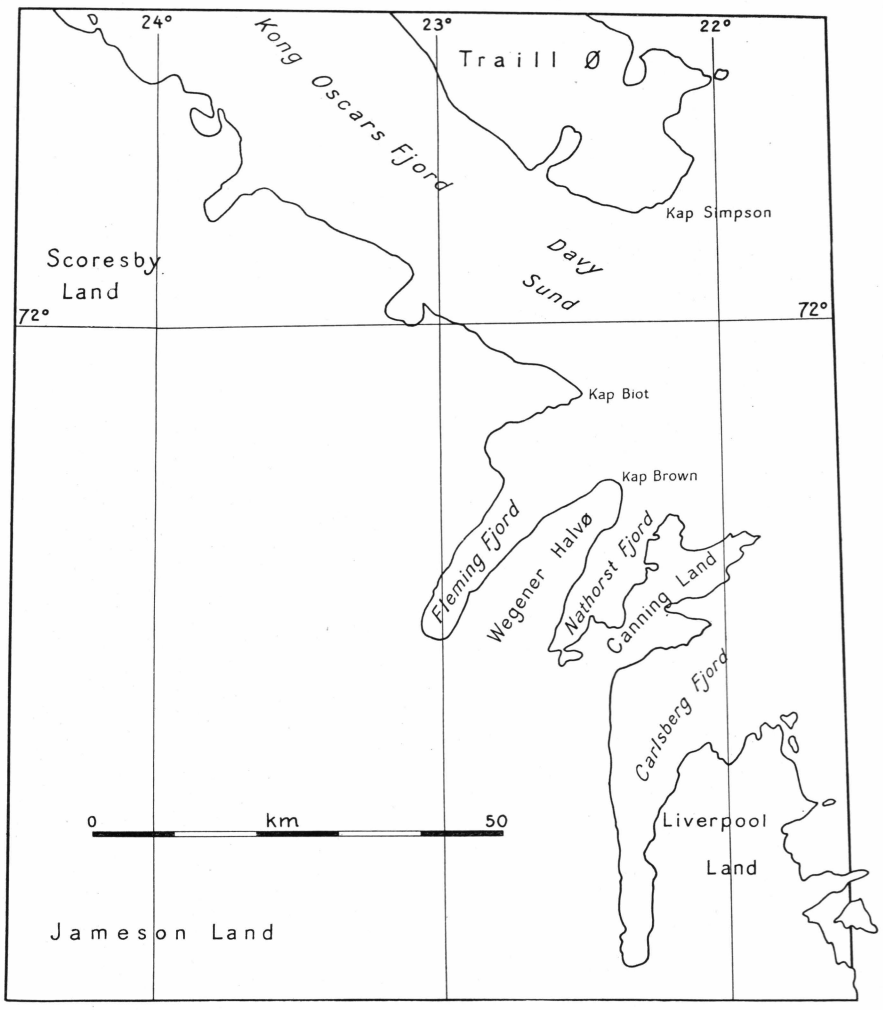


Fig. 1. Sketch map of the region around Davy Sund.

II. THE GEOLOGICAL INVESTIGATION OF CANNING LAND

O. NORDENSKJÖLD (1907), who was the first to give a geological description, a map, and sections of Wegener Halvø and Canning Land, was only able to make observations in a few places situated far from each other within these regions: in the interior of Fleming Fjord, at Kap Brown, at Kap Fletcher, and in Hurry Fjord. On account of this random investigation it was to a great extent left to chance which geological formations were observed. Since, moreover, fossils were only found in the Triassic series in the western part of Fleming Fjord, it was impossible for NORDENSKJÖLD to make a reliable determination of the age of the series of strata outside this region. As regards the stratigraphic determination of the formations he could only draw support from the crystalline rocks in Liverpool Land, which he regarded as Archæan, from the Trias in Fleming Fjord, and from the Rhaetic of Jameson Land. Accordingly he makes some reservation as to the stratigraphic position of the exposures in the eastern part of Wegener Halvø and Canning Land. However, on the basis of observations of the conglomerates containing pebbles which resembled the eruptives found *in situ* at Kap Fletcher, he was able to determine the relative age of the rocks at Kap Fletcher, the conglomerates at Kap Brown and the sandstone series associated with the latter.

In the eastern part of Wegener Halvø, along the north coast towards Kap Brown, NORDENSKJÖLD distinguished three different series:

1) Red and green shales along the sea, which, in the field, he first took to be crystalline, but which on the microscopical examination turned out to be clastic.
2) A conglomerate, likewise near the shore, with different pebbles, i. a. porphyry and porphyrite, which much resembled the eruptives at Kap Fletcher on Canning Land. Accordingly the conglomerate must be younger than the eruptives and the sediments penetrated by them.

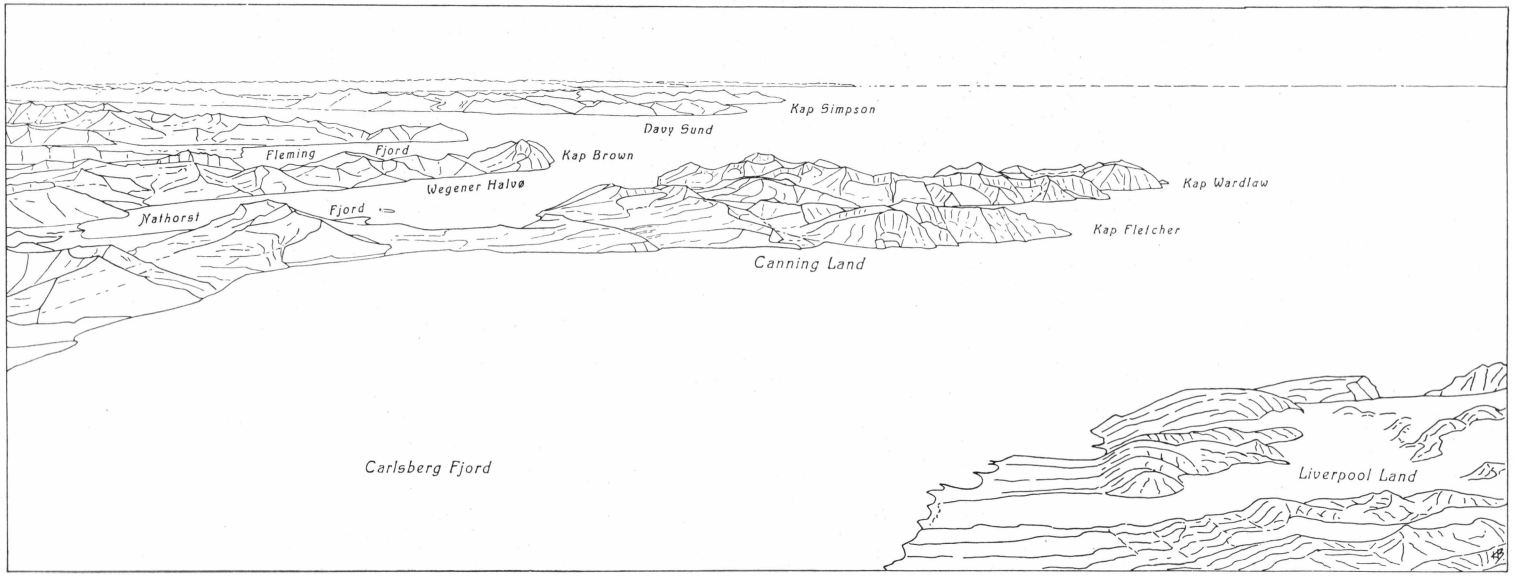


Fig. 2. Looking north from Carlsberg Fjord, drawn from air photographs taken by the Geodetic Institute, Copenhagen.

3) Red shales at the top of the mountain at Kap Brown, which seem to bear some resemblance to those from the shore mentioned under 1). However, according to NORDENSKJÖLD they bore a much greater resemblance to some sandy shales from the upper Triassic in the western part of Wegener Halvø.

NORDENSKJÖLD therefore assumed that these upper shales, which build up the top of the mountain, were Triassic rocks, and the conglomerate along the sea must then, considering its rather horizontal bedding, belong to the older Trias or the Permian. But as to what formations the red and green shales along the shore belong, he gives no further information. The following passage has probably reference to these rocks (1907, p. 179): ". . . but until a detailed examination has been undertaken the possibility is always present that we have to deal with an older Paleozoic series which by dislocation is separated from the more recent beds."

At present it is a matter of fact that the shales at the top of the mountain at Kap Brown are of Middle Devonian age. The conglomerates along the sea are probably Devonian conglomerates, and the green and red shales probably correspond to the pre-Cambrian Eleonore Bay Formation. However, since precise information about the locality in which the observations were made is lacking, nothing definite can be said about it.

At Kap Fletcher on the south side of Canning Land NORDENSKJÖLD found a thick series of limestones, calcareous breccias, shales, phyllites, and sandstone beds which were pierced by porphyritic eruptives in the shape of dykes and stocks. He called the sediments the Kap Fletcher Series and the dykes the eruptives of the Kap Fletcher Series. From the finding of pebbles at Kap Brown he concluded that the Kap Fletcher Series was older than the conglomerate at Kap Brown, and assumed that it might be Silurian-Devonian. He found support for this assumption in the stratigraphic determinations of NATHORST (1901), who designated the sedimentary series of Kong Oscars Fjord, which have at present been determined to be pre-Cambrian, Cambrian, and Silurian, as Silurian and demonstrated that they were overlain by Devonian sandstones.

We know at present that the sedimentary series at Kap Fletcher belongs to the pre-Cambrian Eleonore Bay Formation and that the eruptives piercing it must be older than the basal conglomerates of the upper Middle Devonian.

Similar rocks to those occurring at Kap Brown were found by NORDENSKJÖLD on the east coast of the northern part of Hurry Fjord in Liverpool Land. Already NATHORST observed these beds and referred the uppermost of them, which underlie the Rhaetic, to the Keuper. Above the "Archæan crystalline rocks" of Liverpool Land NORDEN-

SKJÖLD observed a hard conglomerate with interbedded shales underlain by a peculiar series of green and red shales with dark limestone beds. In one place he found, in the conglomerate, red granite and porphyry pebbles which could not be derived from the nearby Liverpool Land and which resembled the eruptives of Kap Fletcher. A still higher-lying conglomerate in Ryders Dal, which likewise contained porphyry pebbles, he designated as upper Triassic and parallelised it with the beds in Fleming Fjord, where they were subjacent to the Rhaetic. NORDENSKJÖLD compared the lower conglomerates and the shales with the series at Kap Brown and accordingly assumed them to originate from the older Triassic or the younger Palæozoic times. So far it has not been definitely determined how old the rocks of these old series of Hurry Fjord are. In his geological map KRANCK (1935, pl. 3, in the legend Nos. 3 and 4) indicates them with reservation as Devonian and Cambro-Ordovician. In my opinion the lower beds may be quartzitic slates of the pre-Cambrian Eleonore Bay Formation, in part also volcanic rocks corresponding in age to the Lower or Middle Devonian Kap Fletcher eruptives. The immediately overlying compact and hard conglomerate may be Devonian. If so, the comparison with Kap Brown made by NORDENSKJÖLD would be correct. Further, it may be of interest that NORDENSKJÖLD indicates these older sediments on the west side of Liverpool Land to be separated by a fault from the adjacent crystalline rocks to the east (1907, section II). According to my own observations this is correct.

As regards Wegener Halvø and Canning Land no tectonic connection can be distinguished in the maps and profiles of NORDENSKJÖLD, not even with Liverpool Land, which is designated as an Archæan horst.

From the year 1926 LAUGE KOCH, through his work in the field and the expeditions under his leadership, has caused a revival of the geological investigations in East Greenland. On the sledge journeys made by KOCH (1929), starting from Scoresbysund, he investigated a great number of exposures along his sledge route and collected a large material of fossils. We are indebted to him for a great many important stratigraphic and tectonic results. Thus for instance the division of the ancient sediments of East Greenland into the late-Algonkian Eleonore Bay Formation and various Cambrian, Ozarkian, and Ordovician divisions. KOCH pointed out that they represented series which were deposited in an ancient geosyncline and had been transformed into folded mountains by Caledonian movements. As regards the Devonian beds he demonstrated their unconformable superposition on the folded Caledonian substratum and compared the East Greenland Old Red with the Alpine Molasse.

In the region around Nathorst Fjord KOCH found various series of beds which were unknown prior to his sledge journeys, thus on Wegener

Halvø the marine "Carboniferous-Permian limestones" (Mallemuk Formation), on Depot Ø west of Canning Land a younger Permian series, in Nordenskjöld Fjæld a lower, and at Kap Biot at the mouth of Fleming Fjord an upper, Triassic series. At the same time HARRIS (1931, 1932) found "continental Carboniferous" near Calamites Dal on Wegener Halvø, and ROSENKRANTZ (1929, 1930) investigated the Triassic and Jurassic series in Klitdal.

On Canning Land KOCH made no detailed measurements. In the western part of the peninsula, however, he met with marine limestones of the "Upper Carboniferous" underlain by light-coloured coarse sandstones of the continental Lower Carboniferous (KOCH, 1929, p. 92). NOE-NYGAARD (1935, p. 490) has later denied the occurrence of continental Carboniferous on Canning Land, however, recent investigations have shown that KOCH's observation was correct.

KOCH wrongly parallelised the dolomites of the Kap Tyrrell mountain and the Kap Fletcher peninsula with the dolomites of the "marine Carboniferous" and accordingly assumed the Kap Fletcher eruptives, pebbles of which also occur in the Triassic beds, to be Permo-Carboniferous.

Eruptives which in the field resembled those at Kap Fletcher were also found by KOCH in more remote localities (cf. KOCH 1929, p. 119 and pl. II); he gave them the collective name of the "Kap Fletcher series". On the later expeditions under the leadership of KOCH it was found that the dolomites in eastern Canning Land are of pre-Cambrian age. It turned out that not all the eruptives comprised by the name of the Kap Fletcher series were of the same age. Accordingly this term can no longer be used in the sense defined by KOCH.

In contrast to NORDENSKJÖLD, who regarded Liverpool Land as an Archæan horst, KOCH took the crystalline rocks here to be Caledonian and, since the Permian time, to have formed a block in connection with the area of the present Jameson Land. In Permo-Triassic time this block had been tilted towards the northwest, the southern Liverpool Land having been elevated and the northwestern Jameson Land lowered. In Jurassic times, however, the subsidence was most important in the southwest and the upheaval in the northeast, while during Tertiary times a considerable upheaval took place in the east and a strong subsidence in the west. These views are in the main in accordance with those held by VISCHER (1937, 1943) on the basis of recent investigations of the antithetic step-faults along the coast of East Greenland and by STAUBER (1942) on the basis of investigations of the Triassic beds on Jameson Land.

In the years 1931—1934 A. NOE-NYGAARD (1934, 1937), as a member of the expeditions led by KOCH, several times made detailed investigations on Canning Land and Wegener Halvø and mapped the various forma-

tions. In addition to new occurrences of the beds already known within the area he found thick Devonian deposits. On the basis of a find of fossils made by him on Wegener Halvø, the occurrence of upper Middle Devonian could be determined by G. SÄVE-SÖDERBERGH (1933). In his first paper, NOE-NYGAARD in the main took over the stratigraphic determinations made by KOCH as to the age of the sediments and eruptives on Canning Land. In a later paper (1937), however, he revised his earlier statements on many essential points, giving a largely correct picture of the geological and stratigraphical conditions. Thus he states that the eastern part of Canning Land is made up of folded Caledonian rocks, which are overlain in the west by Devonian, Permian, and Triassic beds. He ascertained that the eruptives at Kap Fletcher are younger than the main folding of the Eleonore Bay Formation, that is, post-Caledonian, and older than the Devonian deposits within this region. From the occurrence of porphyry pebbles in the Devonian, Carboniferous, Permian, and Triassic conglomerates he concluded that intense erosion had taken place in this region at the beginning of these periods.

The cursory investigations in the field made by G. SÄVE-SÖDERBERGH and H. BÜTLER in September 1936 and referred to in the Preface, had for their object the solution of some special problems. Thus on the basis of the fossils collected by himself G. SÄVE-SÖDERBERGH (1937, 1938) determined the Old Red of Canning Land to be Middle Devonian and divided it into several series. Here, also, he ascertained that the Middle Devonian was overlain by continental Carboniferous beds, and defined the place that was within the local series between the Permian and the Trias to be assigned to the Depot Island formation erected by KOCH. BÜTLER (1937) pointed out the geological position of Canning Land, which lies as a connecting area between the upheaved region of Liverpool Land and the Mesozoic depression of Jameson Land and Scoresby Land, so here, near each other, the disturbances and erosion of the series of strata as a consequence of the upheaval as well as the coarse sedimentation in the area of deposition near the margin of the basin can be observed.

The works by H. ALDINGER (1935) and W. MAYNC (1942) give information about the age of the marine Permian limestones, the earlier "marine Carboniferous" or "Permo-Carboniferous". A. VISCHER (1943) has traced the course of the large faults on the east coast of Greenland along a great distance and given a clear description of the block-faulting tectonics within the coast region. STAUBER (1942), on the basis of the sections measured by him, reconstructed the development of the sedimentation basin in the regions west and northwest of Canning Land during Triassic times. Contributions to our petrographic knowledge of the rocks occurring within the area of investigation have been supplied by NOE-NYGAARD (1937) and RITTMANN (1940) as regards the eruptives, and by KLEIBER (1944) as regards the sediments.

III. THE GEOLOGICAL POSITION OF CANNING LAND

1. Synopsis.

In recent years various synoptic accounts of the geological structure of the coast of East Greenland have appeared. For accurate information the reader is principally referred to the papers by L. KOCH (1933, 1935, 1937, 1939), E. WEGMANN (1937, 1939, 1939 a), and A. VISCHER (1943). According to these accounts the area between the sea and the inland ice north of Scoresby Sund can be divided geologically into two large longitudinal zones, both of which are made up of fragments of the Caledonian folding zone.

The western zone, farthest inland, which is built up of crystalline rocks and Caledonian sediments, extends along the eastern edge of the inland ice. In the west they are covered by the ice, so there their boundary towards other large tectonic elements is unknown. On the east side, however, the folding zones are cut through by deep fjord valleys, and beautiful sections are exposed in their steep slopes. The longitudinal extension of this zone on the whole almost coincides with the direction of the folds of the Caledonian superstructure, to the north forming an acute angle with the outer coast, which it reaches in the region of Dove Bugt in about 76—77° N. lat. To the south, however, it is removed from the coast and appears in the inner ramifications of Scoresby Sund, whence its southern continuation is unknown. This inner zone is on the whole an ancient area of upheaval, which to-day, as in earlier geological times, supplies material for the sedimentation in the eastern fjord zone. In the middle trend of the zone the erosion surfaces cut deep into the crystalline basement of the Caledonian mountains. A synopsis of the structure and material of these mountains has been given by WEGMANN (1935).

The eastern, outer zone extends across the peninsulas and the islands of the outer coast between Scoresby Sund and Nørlund Land. Since Carboniferous times it has chiefly been an area of subsidence, in which the Caledonian basement was at times submerged and covered

with sediments over vast areas. The oldest of the superjacent beds originate from the Devonian period, from a time when late orogenic movements still made themselves felt in the eroded Caledonian ridges. The distinct separation of the two zones took place in Carboniferous times. The boundary between them, the uplift-denudation zone in the west and the late Palæozoic-Mesozoic subsidence and sedimentation area in the east, is characterised over large stretches by faults of considerable throw. VISCHER (1943) describes their importance and the part played by them in the geological development of the Northeast Greenland coastal area in post-Devonian times. Towards the east this zone of subsidence passes into the shelf, and its original extension in width is accordingly unknown. In an important paper WEGMANN (1943) points out the possibility that this East Greenland area of transgression and regression might for a long period have formed the northern termination of the North Sea.

2. Geologic-tectonic Classification of the Crystalline Area between Scoresby Sund and Nørlund Land.

In the area of Caledonian folding in East Greenland the crystalline rocks, gneisses, migmatites, and granites are exposed over vast stretches. In the inner zone defined above, the Vela zone of KOCH (1935, fig. 10), these rocks occupy a broad continuous middle belt on the geological map. In the east and west this crystalline zone is accompanied by a broad belt of folded, only slightly metamorphosed Caledonian sediments (cf. KOCH 1933, fig. 2, 1935, p. 136, WEGMANN 1935, ODELL 1939 and 1944, and other authors). On the inland side it is designated the "western marginal zone" or the zone of the Petermann Series or the nunatak zone, while in the east it is called the Eleonore Bay Formation or fjord zone (WEGMANN 1935). The latter zone is cut through by several fjords, and almost all determinations which supply information about the succession of the series and the development of the Caledonian geosyncline in East Greenland are derived from this zone. In the late pre-Cambrian Eleonore Bay Formation within this region, which comprises beds of dark quartzitic shales and dolomitic limestones of a thickness of several thousand metres, some anticlines and synclines of the Jurassic type can be observed (cf. KOCH 1929, TEICHERT 1933, WEGMANN 1935). In the cores of the synclines sub-Cambrian tillites, shales, and limestones of Cambro-Silurian age are preserved.

The transition from the highly metamorphosed deep-seated rocks to the unmetamorphosed sediments of the Eleonore Bay Formation is always reflected in the deeper quartzite series of the Eleonore Bay Formation, in so far as it has hitherto been observed, though at varying

altitudes within this sequence of rocks some thousand metres thick. Where there is a sharp boundary between the crystalline basement and the non-metamorphic upper series, it has arisen through a later dislocation of the series during the orogenic movements.

So far the ancient pre-Cambrian crystalline substratum of the sedimentary Eleonore Bay Formation has not been observed anywhere. KOCH, BACKLUND, and especially WEGMANN are of opinion that during the development of the Caledonian mountain structure the transformation front rose above this deep transgression surface. The older pre-Cambrian substratum was so highly transformed and included in the folding that it can no longer be definitely recognised and distinguished, and the outcropping crystalline rocks must accordingly be regarded as Caledonian. On the basis of my observations, made in Hudson Land and Ole Rømers Land in similar stratigraphic boundary zones, I agree with this view. ODELL (1939), however, is of opinion that the development of the gneiss dates much farther back than the Caledonian orogeny, referring it to an ancient extensive pre-Cambrian regional dynamic metamorphism. The central crystalline mass, in which the granitic gneisses are predominant, is regarded by him as the old resistant pre-Caledonian block.

North of Franz Josephs Fjord, almost from Waltershausen Gl., the axes of the folds within the eastern zone of sediments rise towards the north, the crystalline rocks of the deep zone cropping out at the surface, first in the anticlines in the eastern part of Ole Rømers Land, then farther northward, in Payer Land, also in the synclinal folds. Accordingly the central crystalline zone extends eastward at the expense of the eastern sediment belt, which has been elevated above the level of erosion.

From Kong Oscars Fjord to some distance into Ole Rømers Land Devonian conglomerates and sandstones rest, to the east, on the folded Eleonore Bay zone. They were deposited as late-Caledonian molasses in an elongated inland intermontane depression, and in the region where the depression was deepest they attain a thickness of a few thousand metres. The bottom of this trough, like the Caledonian folds, rises towards the north. Hence the deeper Devonian series appear at the surface north of Gauss Halvø, near Musk-ox Fjord, and in Hudson Land. In these beds occur ridges of gneiss covered by a mantle of Devonian beds, the lowermost of which have been tilted or folded, while the upper younger beds overlie them unconformably, forming almost horizontal beds. I have previously shown (BÜTLER 1935, 1936, 1939, 1940) that these crystalline ridges penetrating the lower Devonian series are portions of the Caledonian substratum which in Devonian times have been uplifted and in part overthrust to the west. By means of the folded and un-

conformable Devonian series it is possible, north and east of Moskusokse Fjord, to distinguish three large crystalline zones that have been thrust up into the Devonian beds: That of the so-called crystalline inlier at the western entrance to Moskusokse Fjord, that in Nørlund Alper, and that found in La Cour, Anker, Nordhoek, and Giesecke Bjærge. The middle zone, that in Nørlund Alper, rising northwards, occupies a more and more extensive area and continues north of Wordie Bugt in Jordanhill and across Blosseville Bjærg into eastern Payer Land. The eastern crystalline zone, however, is cut up into blocks by the post-Devonian main fault and several minor fractures. Thus the connection has been interrupted and the original picture may only be reconstructed by means of very accurate investigations in the field.

Between the crystalline zones of the Devonian Hudson Land area and the Caledonian zone west thereof in Ole Rømers Land there is a broad syncline which has been somewhat compressed through late-Caledonian thrusting activity. To the south it is filled with Devonian deposits, while to the north the overlying beds have been removed by erosion and in agreement with the axial rising the substratum crops out: At first the Cambro-Silurian, then the tillites, and, resting upon them, the different parts of the pre-Cambrian Eleonore Bay Formation. The descriptions by MITTELHOLZER (1941) show that owing to the convergence of the Caledonian folds in the western zone with the Devonian thrusts in Hudson Land this trough wedges out farther northward, and the crystalline masses of the two areas meet.

As regards the crystalline ridges which crop out near the outer coast VISCHER (1937, 1939, 1943) has demonstrated that they represent the margins of blocks tilted towards the west. The western portions of the blocks have at times subsided below the level of the sea and been covered by sediments, while the eastern parts were uplifted and subject to erosion, so that the crystalline basement was exposed. In the investigation of the eastern zone of faulted blocks this Caledonian basement has mostly been used simply as a collective term, i. e. as the substratum of the younger stratigraphic series; little attention has been given to its structure and its place in the ancient sequence of rocks. However, recent investigations in this direction have been published by BACKLUND (1932), KRANCK (1935), and MITTELHOLZER (1941).

Between Giesecke Bjærge north of Franz Josephs Fjord and Liverpool Land, along a stretch of nearly 200 kilometres, in contrast to the more northerly regions, no crystalline ridges are met with neither in the Devonian area nor east of the large fault. In the Devonian sandstones of Ymer Ø, Geographical Society Ø, and Traill Ø there are, indeed, folds which must correspond to deformations in the Caledonian substratum, and according to STAUBER (1942) the younger sediments in the

eastern parts of these islands likewise form step-faults. However, the Caledonian basement lies everywhere below sea-level and is covered by younger sediments. Between Franz Josephs Fjord and Davy Sund a broad depression is traceable in the beds of the Mesozoic series. It was called Kongebugten by KOCH (1929, 1935).

South of Davy Sund the long crystalline ridge of Liverpool Land rises from this zone of subsidence. To the east it descends steeply into the sea, while to the west it passes with a sloping peneplain in below the Triassic and Jurassic table of Jameson Land. Towards the large fault along the eastern boundary of Stauning Alper the tabular sediments rise again, and according to STAUBER (1942) they form a flat synclinal trough some 80 to 100 kilometres broad. In accordance herewith KOCH, ALDINGER, STAUBER, and VISCHER regarded the area of Jameson Land—Liverpool Land as a large block tilted towards the west, the elevated eastern edge of which was formed by the crystalline rocks of Liverpool Land. The tilting of the block was inferred by KOCH on the basis of the position of the Triassic and Jurassic sediments and their transgression surfaces.

The western slope of Liverpool Land has been regarded as part of the denuded Triassic transgression surface (cf. ROSENKRANTZ 1934, pl. 13). To the west this plane first intersects the crystalline beds of Liverpool Land, then the old shales and conglomerates of the Hurry Inlet series of NORDENSKJÖLD, and subsequently it disappears below the Triassic beds. In Canning Land, the northern continuation of Liverpool Land, remnants of an ancient strandflat sloping towards the west can be seen. It belongs, however, to the transgression surface of the marine Upper Permian, which there cuts through a series of older dipping sediments before disappearing below sea-leval, viz. the Eleonore Bay Formation, the volcanic Kap Fletcher Series, and Middle Devonian and Carboniferous sandstones. Owing to the presence of these older sediments Canning Land and Wegener Halvø are of special importance. For they are the only regions south of Franz Josephs Fjord in which older sediments occur east of the large fault in connection with the Caledonian substratum which may provide information about the events that have taken place between the Caledonian mountain-building activity and the late-Palæozoic block-faulting and peneplanation.

Geologic-tectonically the crystalline area between the Scoresby Sund region and Dove Bugt may be grouped as follows:

1) An inner western crystalline zone, which corresponds to the central part of the Caledonian highland in East Greenland.

2) The crystalline massifs of Hudson Land and Payer Land, which were elevated from the Caledonian basement by Devonian thrusting.

In this intermediate block, occupied in part by Devonian rocks, they have preserved the relations and position which they had in Devonian times.

3) The crystalline ridges of the eastern edges of the blocks, which were elevated through post-Devonian block-faulting and tilting. They are found east of the post-Devonian main fault defined by VISCHER.

Liverpool Land belongs to the third group of these crystalline tracts; Canning Land also forms part of the elevated edge of the block, but owing to the slighter elevation it has escaped too deep erosion. The older rock series of Canning Land belong to the socle of the Liverpool Land—Jameson Land block and have connection with the late orogenic movements of the Caledonian cycle. On the basis of the position of the beds an attempt will be made to reconstruct an ancient fold in the Caledonian substratum and from the pebbles found in the conglomerate to draw conclusions as to some events that have taken place in the period between the Caledonian mountain-building activities and the Permo-Triassic transgression.

IV. STRATIGRAPHIC DIVISIONS AND STRUCTURAL POSITION OF THE FORMATIONS ON CANNING LAND

1. Pre-Cambrian.

a. Distribution.

Rocks of the lower and middle parts of the late pre-Cambrian Eleonore Bay Formation cover about 89 km² of Canning Land, and thus occupy the main part of the peninsula. The smaller peninsulas of Kap Tyrrell, Kap Fletcher, and Kap Wardlaw are made up of these rocks and in part also of late Caledonian granites. The occurrence of these rocks on Canning Land was first mentioned in the geological literature by A. Noe-Nygaard (1936, 1937, fig. 2 and pp. 11—15).

A line of valleys which crosses the peninsula of Canning Land from Nathorst Fjord to Carlsberg Fjord, to the north called Porfyrdal, to the south Basisdal, separates the eastern area, which is almost exclusively made up of pre-Cambrian rocks, from the adjoining Devonian area to the west. The two areas are separated by a fault, which forms a sharp boundary between the eastern part, folded in Caledonian time, and the western lowered area occupied by tilted younger sedimentary tabular formations. Thus the two areas differ also in the character of the landscape, and in the direction and shape of the valleys and mountain ridges.

Even from a distance a thick series of varicoloured shales and limestones are remarkable on account of their bright colours; they occur *in situ* to the north in the mountain of Kap Tyrrell and in the south along Aalborg Fjord in the coast cliffs of the Kap Fletcher peninsula. In the former place the beds dip towards the northwest, towards Nathorst Fjord, while at Kap Fletcher they descend towards the south into Carlsberg Fjord. Evidently the varicoloured shales and limestones form the two slopes of a broad anticline, the limbs of which diverge towards the east, indicating the rising of the axis of the fold in this direction.

The core of the anticline is formed by dark quartzitic shales and slates of the lower part of the Eleonore Bay Formation, and at Kap

Wardlaw, where the erosion owing to the pitch has gone deepest, granites are exposed. They form the transition to the crystalline series of the Caledonian folds.

b. Stratigraphical Divisions.

In the facies characters and the main features of the stratigraphical divisions the pre-Cambrian of Canning Land agrees with the lower and middle series of the Eleonore Bay Formation in Lyell Land and the regions farther north. KOCH (1935, p. 59) called these series late pre-Cambrian and included them, together with the Thule Formation and the Petermann Series, under the name of Grönlandium. BUBNOFF (1944), on the basis of their connection with the Caledonian geosyncline and their association with the early Palæozoic cycle, refers them to the Eocambrian.

As the lowermost member of the non-metamorphic Caledonian sedimentary series we here meet with dark, almost black quartzitic shales; they form the main part of the Canning Land anticline. Dominant are quartzitic, partially clayey and micaceous shales, in which varve structures, ripple marks, and sun-cracks can be observed. They are interbedded by dark reddish-brown shales and, especially in the upper part, by white or reddish quartzites.

At Kap Wardlaw the quartzitic shales are penetrated by a light greyish granite. It is sharply delimited from the shales, forming stocks and veins, and a network of apophyses extends sidewards and upwards through the adjacent rock. Even from a great distance the dykes and stocks are distinguishable by their bright colours from the dark shales. A. NOE-NYGAARD (1937) compares correctly this granite with those of Anker Bjærg at Moskusokse Fjord.

On Canning Land the granite stocks and dykes have preserved their original connection, being neither crumpled nor cut off from the quartzitic series. However, the granite as well as the schists pierced by it have been thrust towards the northern side of the anticline and have participated in the last movements during the Caledonian mountain-building activity as a stiff mass. The characters stated by WEGMANN (1939, p. 96) for the youngest Caledonian granites fit on the Kap Wardlaw granite. He characterises them as granites which have risen above the general level of the crystalline infrastructrure and have been involved in the final phase of the Caledonian folding activity as comparatively stiff masses.

In the upper part of the series of sandy shales deep reddish-grey and greenish beds alternate with numerous beds and bands of hard white or pink quartzites. These beds are well exposed in Aarhus Bjærg, the eastern part of the mountain ridge extending on the north

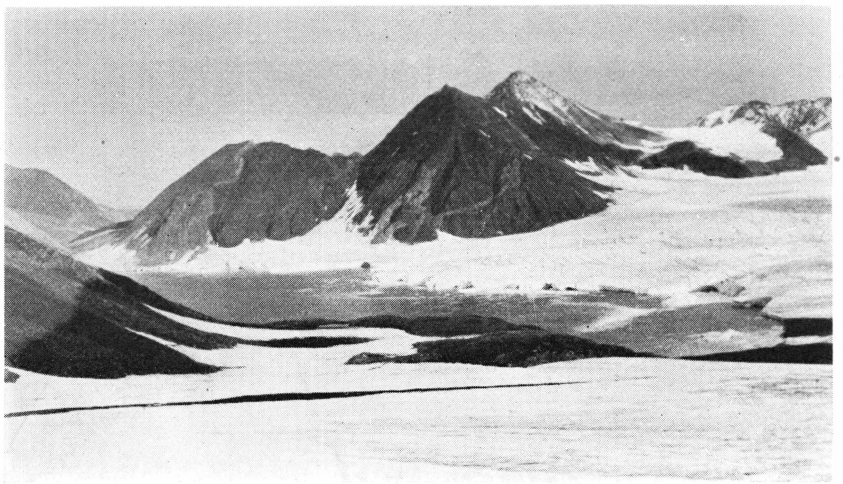


Fig. 3. Locality: Western, innermost shore of Aarhus Bugt. View towards the southeast, towards Bowens Bjærg on the Kap Wardlaw peninsula. The mountains south of the bay consist of black quartzitic slates of the lower part of the Eleonore Bay Formation and are penetrated by light-coloured dykes of the Kap Wardlaw granite. The highest mountain, Mont Bowen, is built up of light-coloured massive Kap Wardlaw granite.

side of the short shallow valley which runs from Doubletvigen to Aarhus Bugt, and further in the pass between Aarhus Bugt and Snevigen south of the mountain at Kap Tyrrell.

Above the banded quartzites of the upper part of the series of quartzitic shales succeeds the middle division of the Eleonore Bay Formation, the so-called multicoloured series (TEICHERT 1933), which represents an alternation of variegated quartzitic shales and yellow and grey dolomites. It is these beds which in the mountain of Kap Tyrrell attracts one's attention even from a distance and a section of which is given by NOE-NYGAARD (1937, p. 15). In the south side of the mountain the following section can be observed from below upwards:

1) Shales, intensely red on weathering, terminated above by some yellow bands of dolomite. Total thickness 200—300 metres, the boundary towards the underlying dark quartzite interbedded with light-coloured bands cannot be definitely determined.
2) Then follow about 40 metres of shales, strikingly ochre-coloured on weathering, dolomites, and quartzites, in which the transition from the largely quartzitic clayey deposits to carbonaceous rocks is completed.
3) These are overlain by about 100 metres of hard thin-bedded limestones, dark grey on fracturing, which appear as a steep band all around the mountain.

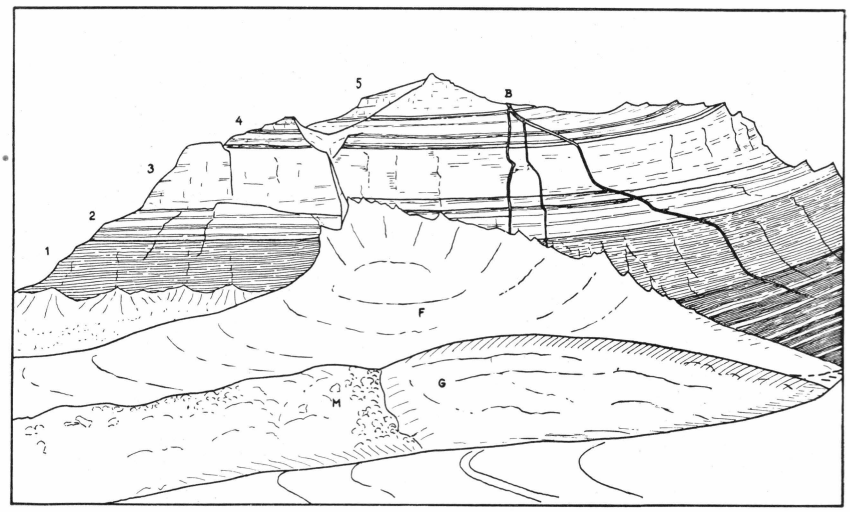


Fig. 4. Perspective sketch of the south side of the Kap Tyrrell Bjærg, viewed almost perpendicularly to the direction of strike of the beds.

Legend:

1—5: The various divisions of the multicoloured series of the Eleonore Bay Formation. The numbers indicate the sections mentioned in the text (pp. 23—24).

5) Limestones forming the summit (summit c. 700 m above sea-level).
4) Varicoloured striated series.
3) Limestones, dark on weathering.
2) Multicoloured series with bands ochre-coloured on weathering.
1) Predominantly dark-red shales.

B) Basaltic dykes.
G) Grey granitic dyke.
M) Moraine.
F) Firn and glacier.

4) Alternating dolomites, quartzitic and softer shales, light-yellow, reddish-brown, blackish-brown, and ochre-yellow on weathering, of a total thickness of about 200 to 250 metres.
5) Limestones forming the top of the mountain of Kap Tyrrell; hard limestones, weathering light-grey, almost white when fractured, preserved to a thickness of about 140 metres. They form possibly the transition to the uppermost part of the Eleonore Bay Formation, the limestone-dolomite series of TEICHERT.

The main part of the upper series of the Eleonore Bay Formation is no longer present on Canning Land. The sub-Cambrian tillites and the Cambro-Silurian rocks are likewise absent. In the Canning Land anticline they were removed by erosion even before the deposition of the Middle Devonian beds.

The same sequence of strata as in Kap Tyrrell Bjærg is seen in the north coast of the Kap Fletcher peninsula, in the steep rock walls rising

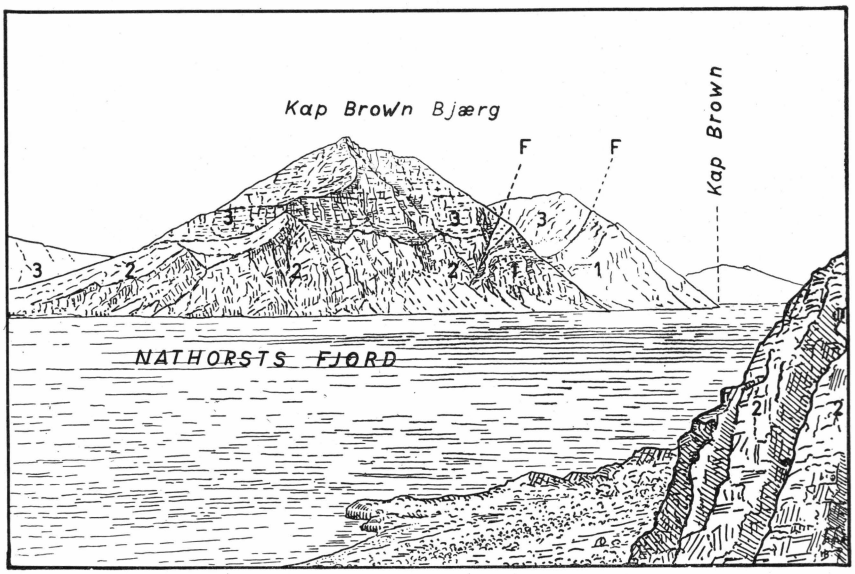


Fig. 5. Southeastern side of the mountain at Kap Brown.

Legend:

1) Dark quartzitic slates of the lower part of the Eleonore Bay Formation.
2) Rocks of the volcanic Kap Fletcher Series.
3) Basal conglomerate and sandstones of the Middle Devonian series.

F) Fault.

from the shores of Aalborg Fjord: At sea-level the red shales (1), overlain by the ochre-coloured band (2), and above this grey limestones (3), succeeded by a varicoloured series (4), and the grey limestones forming the top of the mountain (5). Owing to their great dip towards the south the series is here exposed in a thickness of about 1000 metres, towards the south side of the mountain they are overlain by dark limestones, almost black on fracture, similar to those met with farther north in the upper part of the Eleonore Bay Formation.

c. Wegener Halvø and Liverpool Land.

Beds of the Eleonore Bay Formation seem likewise to be present at Kap Brown in the eastern part of Wegener Halvø. However, I was only able to observe this locality from a distance. The schistose rocks in the coast immediately south of Kap Brown with their white bands probably belong to the upper part of the series of quartzitic shales; towards the northeastern part of the peninsula they are penetrated by the volcanic Kap Fletcher Series. At the southeastern base of the mountain of Kap Brown this shaly series is interrupted westward by a steeply dipping fault (cf. fig. 5).

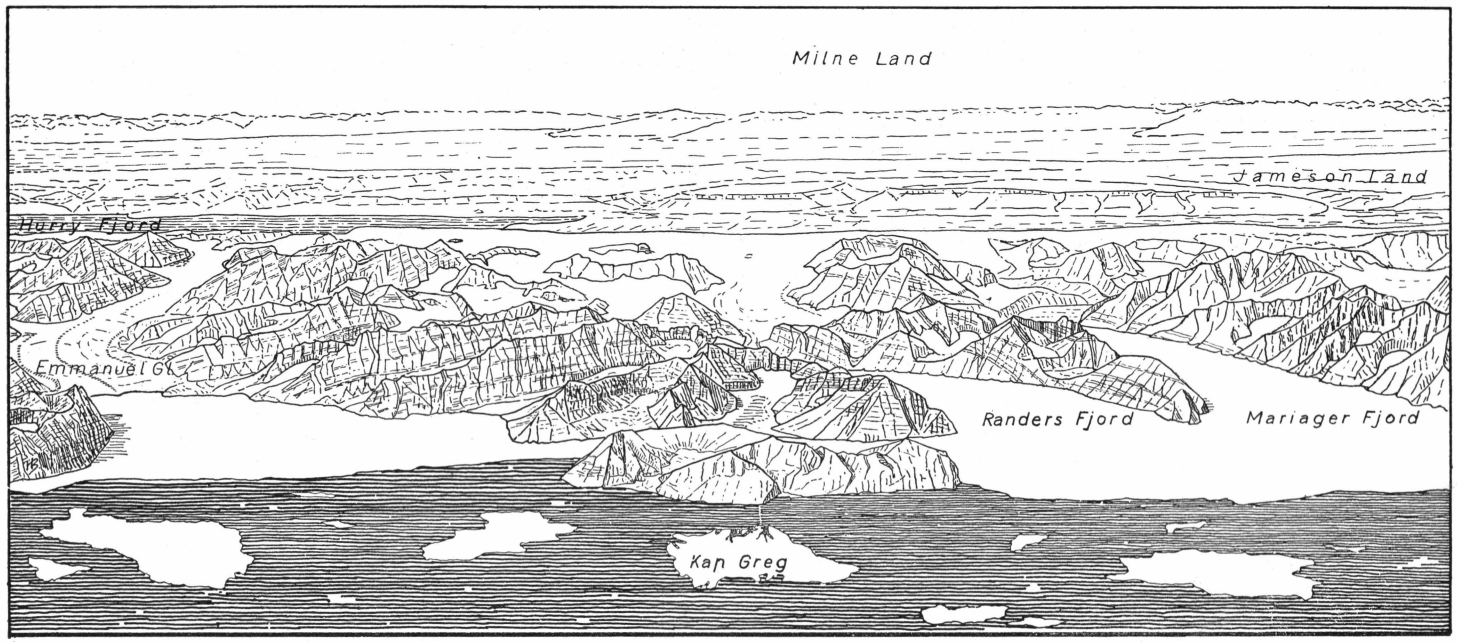


Fig. 6. Broad Caledonian anticline in the migmatitic gneisses at Kap Greg on the outer coast of central Liverpool Land. Drawn from air photographs taken by the Geodetic Institute, Copenhagen. Looking east-west across Liverpool Land and Jameson Land to Hall Fjord and Milne Land. The width of the field of vision along the ice edge in the foreground is about 10 km.

In the mountain ridges between Mariager Fjord and Emmanuel Gl. a broad anticline can be observed formed of the beds of the migmatite gneisses. The fold-axis shows a steep pitch towards the west-southwest.

In the middle of the picture the direction of view is almost parallel with the direction of the crest line of the anticline. North of Mariager Fjord the gneiss arch is flanked by the Caledonian Store Fjord granites. The limb of the fold descending towards the south is traceable about 5 km beyond the left frame of the picture as far as Horsens Fjord, where the migmatites disappear steeply below the granodiorites of the area of the Rathbone Ø. (Cf. the geological map and descriptions by E. H. KRANCK, 1935, p. 101 and pl. 3).

West of the valley of Hurry Fjord the almost horizontal bedding in the Mesozoic Jameson Land Basin can be observed.

Comments on the orography of the area represented in Fig. 6.

The geological crest line of the Kap Greg anticline runs in the direction west-southwest right across the dividing crest of the ridge of Liverpool Land. The disposition of the valleys in the area of the anticline is determined by the structural lines. The drainage takes place towards both sides of the fold, the watershed extends inland across the narrow spit of land of Kap Greg to the crest line of Liverpool Land, up into the glacier-filled area, following approximately the axis-plane of the anticline. Two main valleys, one on each side, unite as monoclinal longitudinal valleys with the side valleys coming from the intermediate area. Their lowermost parts (mouths of Mariager Fjord and of the valley of Emmanuel Gl.) are submerged by the sea; in the upper parts the valleys converge. The small branch valleys leading outwards from the anticlinal crest are seen on the map as flat curves open towards the east. They follow the lines of intersection which the surface of the earth forms with the limbs of the anticline. Owing to the considerable westward pitch of the axis of the fold the branch valleys are likewise disposed monoclinally to the bedding plane though they run across the direction of the fold.

The glacial erosion has transformed these branch valleys into steep-walled trough valleys situated between sharp and serrated dividing crests and mostly terminating in a closed cirque.

This picture of erosion can be explained by the fact that the present landscape in this place has developed from an ancient uplifted peneplain. In post-Jurassic times Liverpool Land was elevated as the eastern edge of a large westward tilted block. The subsidence of the axis of the Caledonian fold was increased by the westward tilting of the surface of the block. In the steeper eastern slope of the block the original crest line of Liverpool Land was soon cut across and the watershed shifted towards the west owing to the retrogressive erosion. The drainage system that developed on this steep slope was highly influenced by the denuded Caledonian structures, while on the west side of Liverpool Land the Triassic and Jurassic plateau sediments had first to be romoved. The direction of the drainage furrows towards Hurry Fjord was determined by the westward dipping of the sediment table.

For the construction of the present topographic and geological picture four geometric main components may be deduced for this area, viz.

1) The north-south striking crest line of the Liverpool Land block.
2) A broad anticlinal arch in the area around Kap Greg almost at right angles to this crest with a more strongly westward descending axis than the surface of the land towards Hurry Fjord.
3) A steep erosion plane, descending steeply towards the east from the crest line. River and glacier streams have exerted a highly modelling influence on this surface.
4) The surface of the sea, which to-day lies on a higher level than the bottom of the lower parts of the valley and determines complicated contour lines in this modelled landscape along the east side of Liverpool Land.

South of Carlsberg Fjord, in Liverpool Land, almost exclusively crystalline rocks are met with. This is evident from the maps by NORDENSKJÖLD (1907), KOCH 1929), and KRANCK (1935) as well as from the description of thin sections by KLEIBER (1944). Here the Caledonian superstructure has been entirely removed by erosion, so that the deeper granitic rocks and the crystalline schists are exposed. Some broad anticlinal folds can be seen in the migmatites in the eastern part of Liverpool Land. Especially in the middle part of the coast, near Kap Greg, an anticlinal arch nearly 20 kilometres broad rises between Marigaer Fjord and Horsens Fjord; the axis of this anticline descends towards Hurry Fjord (cf. fig. 6). Almost on the crest of this broad fold, near Hurry Fjord, lie the rocks called the Hurry Inlet Series by NORDENSKJÖLD (1907) and indicated on KRANCK's map as the Hurry Inlet Formation. There is a possibility that at any rate part of this formation consists of shales and slates of the Eleonore Bay Formation which lie at the upper boundary of the crystalline infrastructure and are penetrated by granites and porphyries.

d. The Canning Land anticline.

The information given above (p. 21) of the distribution of the Eleonore Bay Formation includes an outline of the Canning Land anticline. The dolomites and shales of the multicoloured series, which extend along the fold on either side, on the Kap Fletcher peninsula dip about 50° towards the southwest, while to the north, in the southern slope of the Kap Tyrrell mountain, they dip some 25 to 30 degrees towards the north-northwest, to become somewhat more horizontal towards the north side of the mountain. A median line drawn lengthwise through the Kap Wardlaw peninsula indicates the approximate direction of the axis of the fold. It has also almost the direction east-west, sloping some 20—25° towards the west. On the line Kap Fletcher—Kap Tyrrell the fold, measured in the upper dolomites and at sea-level, has a breadth of c. 15 km.

In the core of the fold minor folds and thrust-planes can be ascertained in the slates. They are cut through by faults intersecting them at right angles, and the anticline is cut up into several segments. Unfortunately it was impossible during the short time at our disposal for the work in the field to map these details, and to elucidate all the complications.

The investigations of the Caledonian part of Canning Land were made with the northern bay, Doubletvigen, as a base. On the southeastern shore of this cirque bay rises a steep cliff made up of dark shales. In this cliff some light-coloured quartzitic bands mark an inverted fold opening towards the north. It strikes in the direction

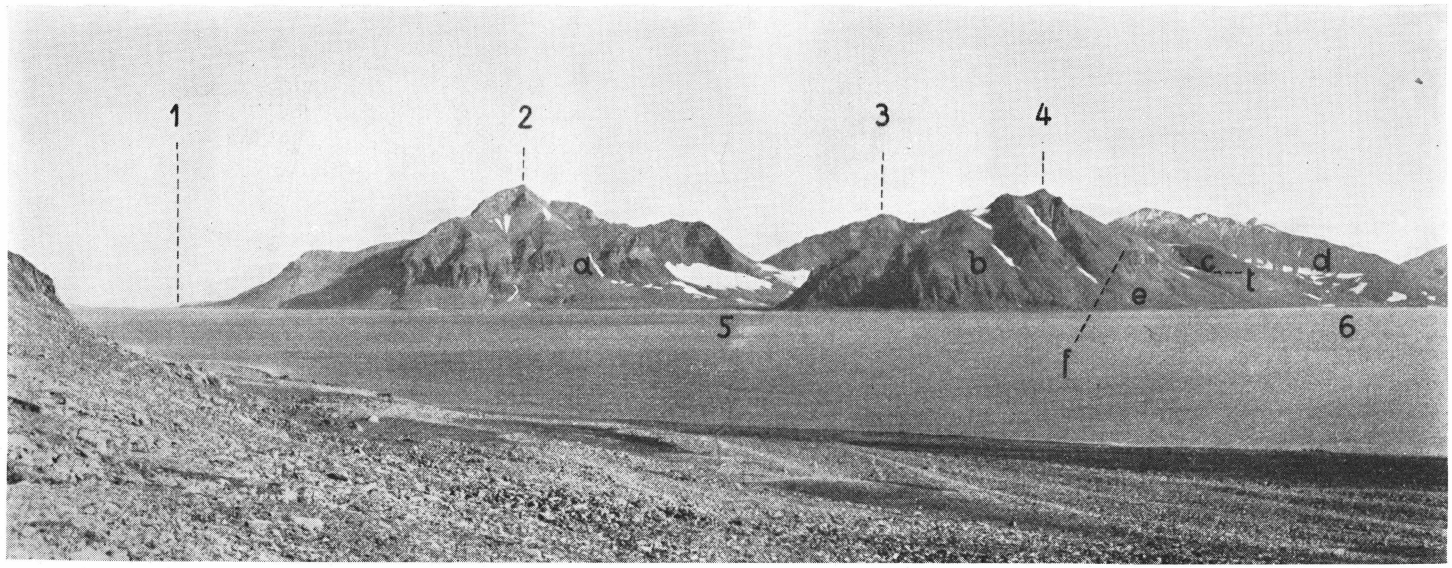


Fig. 7. Kap Tyrrell Bjærg and Porfyrfjæld seen from the northwest, from the southern foot of the mountain at Kap Brown.

Legend: 1 Kap Tyrrell, 2 Kap Tyrrell Bjærg, 3 Aarhus Bjærg, 4 Porfyrfjæld, 5 Snevigen, 6 Doubletvigen.

a) Middle Eleonore Bay Formation. The mountain of Kap Tyrrell is made up of beds of the Multicoloured Series, which here forms the northern limb of the Canning Land anticline.
b) Eruptives and tuffs of the volcanic Kap Fletcher Series. They have been down-faulted so as to form a graben in the northern limb of the anticline.
c) Overthrust dark shales of the lower Eleonore Bay Formation in the south side of Porfyrfjæld.
d) Dark quartzitic shales in the mountain wall north of the cirque bay of Doubletvigen (cf. fig. 8).
e) Limestones and quartzites of the northern limb of the anticline, below the overthrust shales.
t) Thrust-plane.
f) The fault in the west side of Porfyrfjæld.

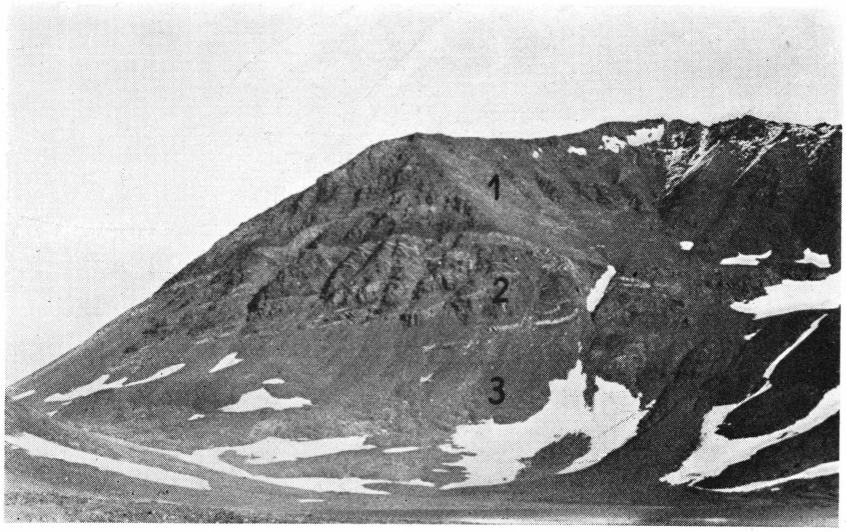


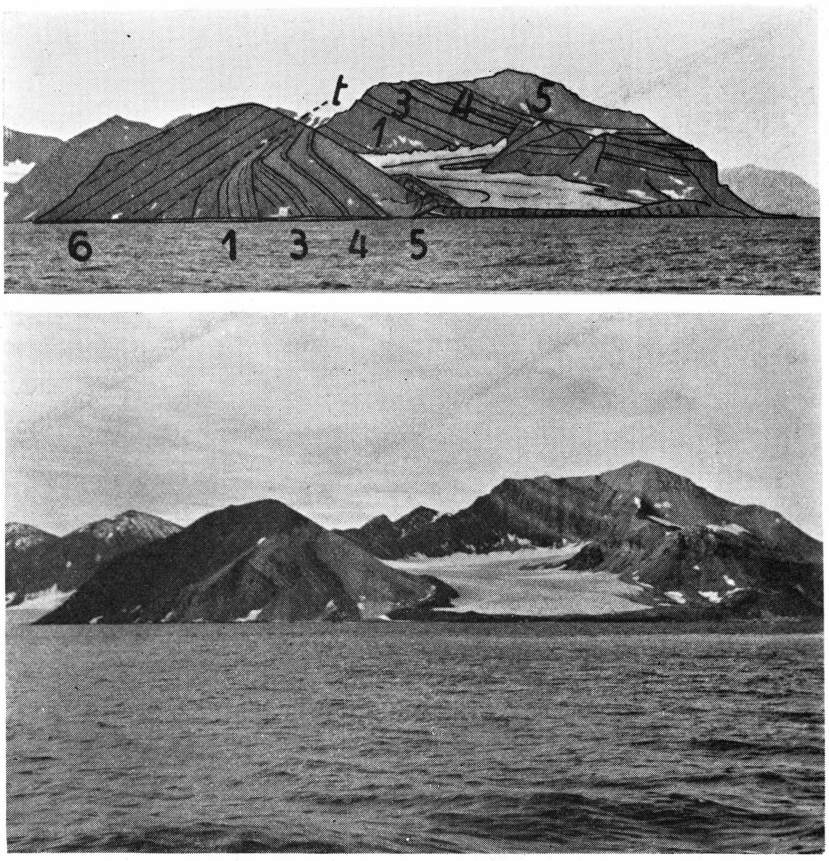
Fig. 8. Locality: South side of the cirque bay of Doubletvigen. Light-coloured quartzitic beds of the upper part of the series of quartzitic shales of the lower Eleonore Bay Formation mark a recumbent synclinal fold. In the mountain wall to the left it is cut off almost parallel to its axial strike; owing to the bending of the wall towards the right an oblique transverse section is visible.

Legend:

1) To the north, upthrust dark quartzitic shales of the deeper part of the core of the anticline.
2) Recumbent synclinal fold between the upthrust core of the anticline and the northern limb of the anticline.
3) Quartzitic shales with light-coloured bands of the upper part of the lower Eleonore Bay Formation in the northern limb of the Canning Land anticline.

west-east and on account of the oblique intersection forms a rather sharp synclinal bend (cf. fig. 8). This inverted synclinal fold can be traced eastward as far as the lower pass leading down to Aarhus Bugt. Seen from the other side, from Aarhus Bugt, the same mountain wall exhibits a transverse section. In its lower portion a series of banded and partially folded quartzites, which descend steeply towards the south, can be recognised (cf. pl. 6). Halfway up the mountain they are intersected by a somewhat more horizontal thrust-plane, which in the north is situated immediately above the small syncline. At the top there is a black shaly mass which no longer exhibits any marked bedding. In some places it is highly contorted.

North of the cirque bay of Doubletvigen similar structural conditions can be observed in the Eleonore Bay Formation along the shore. Turning south along the shore from the fault in the northwest side of Porfyrfjæld, we meet at first with a series of grey dolomitic limestones, which dip 30—35° towards the northwest, but have a very varying strike.



Photograph by S. KAMMAN.

Fig. 9. Kap Tyrrell and the mountain at Kap Tyrrell, seen from the east. The mountain, c. 700 m high, is made up of a normally bedded series of the middle Eleonore Bay Formation. The hill in the foreground, left, shows the upthrust of the dark quartzites of the core of the fold in the northern limb of the Caledonian anticline. On the thrust-plane the beds of the limb of the fold are bent upwards and form the cut off inverted limb of the fold. The thickness of the series is here much reduced.

Legend:

1—5) correspond to the different series of the Multicoloured Series of the Eleonore Bay Formation (cf. fig. 4). Of normal thickness in the mountain at Kap Tyrrell, below the thrust-plane, in the hill at the sea, much reduced.

6) upthrust black quartzites of the lower Eleonore Bay Formation.

t) thrust-plane.

Towards the south there occur, at the base, a highly disturbed series of quartzites which should probably be referred to the upper part of the series of quartzitic shales. The quartzitic bands and limestones are overlain by black shales of the lower part of the series of quartzitic shales. They dip regularly 10—15° towards the southeast and rest unconformably on their substratum. A shearing plane,

dipping southeastward with the shales, separates them from the underlying series.

Further, in the mountains some kilometres south of the cirque bay, a nearly horizontal black series underlain by steeply tilted and folded shales can be seen in the upper part of the northern slope. Here, also, the overlying, nearly horizontal series has probably been thrust over the underlying steeply tilted shales. However, since these rocks are uniform dark shales, which are moreover thickly covered with scree, the structural relations of the two series in this place could not be definitely ascertained.

However, the section at Kap Tyrrell, which, in the east, can be observed from the sea, gives a clear explanation of the unconformity between the lower and the upper series of shales in the various localities. (cf. fig. 9.) The lower hills at the cape have been lowered by a fault extending at right angles to the anticline. In the down-faulted block a fragment derived from the neighbourhood of the crest of the anticline has been preserved. In the coast section of this portion of the fold the lower quartzitic shales of the core of the fold can be distinctly observed to have been thrust up on the multicoloured series of the northern limb of the fold. On the south side of the hill, to the left in the picture, lie black quartzitic shales, which dip towards the south. On the north side, beds of the multicoloured series are met with: red shales, yellow and grey dolomites, and quartzites. Above the thrust-plane they have been bent and dragged in the direction of the dislocation, in the upper part they grow constantly thinner until they are pinched off. But in spite of the much reduced thickness almost the whole sequence of strata of the multicoloured series of the Eleonore Bay Formation in the mountain of Kap Tyrrell, from the red shales to the grey limestones at the top, is represented in this place.

The black shales in the core of the fold have accordingly been thrust up on the multicoloured series along a thrust-plane dipping about 40° towards the south. As shown by the exposures of the quartzites in the elevated part of the fold west of Aarhus Bugt, the thrust-plane is somewhat steeper. In the various segments of the fold the thrust-plane is intersected by transverse faults and the different parts have been displaced in relation to each other. On account of the short time of investigation it cannot be definitely decided whether only one major uplift has taken place or whether several thrust-planes exist within the readily deformable schistose series of the core of the fold.

On comparing the conditions here with more northerly regions it will be seen that the axis of the Canning Land anticline runs in an east-west direction, that is to say, almost at right angles to that of the

fold within the fjord zone. Since the folds in the migmatites in central Liverpool Land also extend parallel to the Canning Land anticline, it cannot be the question of a local anomaly. We do not know how this apparently abnormal direction of folding should be connected with the Caledonian folding in the inner regions of Scoresby Sund and the southern Stauning Alper. No structural maps are available of these regions from which the direction of the folds might be seen. It is therefore doubtful whether in Canning Land and Liverpool Land we are concerned with a bend of the Caledonian chain or only with a branch of the chain.

Now WEGMANN (1935, p. 31 and pl. 1), it is true, has demonstrated that in Suess Land and in the area of the inner ramifications of Kempes Fjord the folds in the migmatites of the Vela massif strike west-southwest to east-northeast, almost at right angles to the nearby eastern supercrustal folds of the fjord zone. Similar phenomena are also known from the Caledonian of Scotland, where the crystalline structures of the Moine gneisses extend at right angles to the Caledonian planes of movement. In Canning Land, however, we are, no doubt, concerned with folds of the Caledonian sedimentary mantle, that is to say, supercrustal structures.

2. The Volcanic Kap Fletcher Series.

a. History and Nomenclature.

In the eastern part of the Kap Fletcher peninsula the pre-Cambrian series of limestones and dolomites is penetrated by dykes, stocks, and lenses of porphyries, in the western half, however, where the limestones have been lowered by faulting, the Eleonore Bay Formation is overlain by volcanic dyke rocks and extrusive rocks. NOE-NYGAARD (1937, p. 54) has pointed out that in the eastern part of the peninsula a deeper level, i. e. the infrastructure of a volcano, is met with than in the western part, where volcanic surface deposits are found.

In some places in Canning Land tuffs and effusive rocks can be distinctly seen to rest unconformably on the Caledonian rocks. The re-deposited weathering products of the volcanic series are found in the basal conglomerate of the superjacent Middle Devonian series. The *mise-en-place* of the eruptives must have taken place after a period of erosion of the Caledonian folds and before the deposition of the sandstone masses of the upper Middle Devonian in this region. NOE-NYGAARD (1937) determined the volcanic rocks to be younger than the main Caledonian folding and older than the Devonian of Canning Land. SÄVE-SÖDERBERGH (1937) determined the age of this Old Red as upper Middle Devonian, and BÜTLER (1937) expressed the opinion that in

regard to time the volcanic Kap Fletcher Series should be placed mush closer to the Devonian formations than to the Caledonian folding and that it probably indicates the beginning of the Middle Devonian sedimentation in this region.

A discrepancy has arisen as regards the designation of these eruptive rocks. NORDENSKJÖLD (1907) called the limestones of the Kap Fletcher peninsula the Kap Fletcher Series and the dyke rocks penetrating them the eruptives of the Kap Fletcher Series. KOCH (1929) used the term the "Kap Fletcher Series" for the eruptives only, whose age he took to be Permo-Carboniferous, and extended the designation to comprise a number of other occurrences of eruptives, which he referred to the same period of eruption. However, later investigations made on the initiative of KOCH have shown that the erruptives found outside Canning Land and Wegener Halvø are much younger. NOE-NYGAARD (1937, 1938) therefore wished to eliminate the designation the "Kap Fletcher Series", since the meaning of it had often changed and the name might give rise to misunderstandings. BÜTLER (1937), however, proposed to maintain the term but to use it only for eruptive rocks formed immediately before the deposition of the Middle Devonian sandstones and conglomerates, that is, the few occurrences of volcanic rocks and dyke porphyries on Canning Land and Wegener Halvø, possibly also their hypogenous equivalents in Liverpool Land. For practical reasons he found it desirable to designate rocks of a certain area which have the same origin and the same age, i. e. are indications of a certain geologic phenomenon, by a suitable collective name. Since in the case in question the determination of the age cannot be quite unambiguous, and rock types of a whole volcanic sequence must be comprehended under one name, it is advisable to use a type locality in giving the name. The largest occurrence is found on the Kap Fletcher peninsula, where the rocks of NORDENSKJÖLD were first found *in situ*. In the following pages I therefore designate these eruptive rocks as the "volcanic Kap Fletcher Series".

A great many rocks of this series have been examined and described by NOE-NYGAARD (1937), and also RITTMANN (1940) has contributed to the petrographic evaluation of them. I therefore confine myself, as a supplement to the petrographical descriptions by these authors, to give some field observations on the geological conditions of this sequence of rocks.

b. Occurrence of the volcanic Kap Fletcher Series.

The localities on Canning Land and Wegener Halvø in which the volcanic Kap Fletcher Series occurs are indicated on NOE-NYGAARD's maps (1934, pl. 2, and 1937, fig. 2).

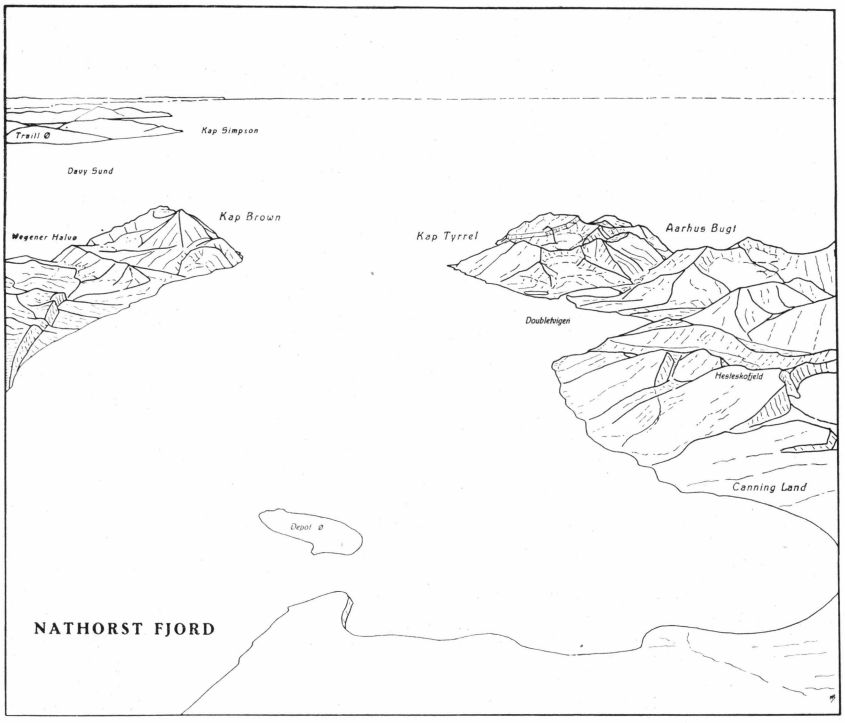


Fig. 10. Looking east across Nathorst Fjord. After an air photograph taken by the Geodetic Institute, Copenhagen.

On either side of the Caledonian Canning Land anticline rests a fairly large remnant of the volcanic Kap Fletcher Series: to the south upon the limestones of the Eleonore Bay Formation on the Kap Fletcher peninsula, to the north upon the same rocks in the Porfyrfjæld west of the mountain of Kap Tyrrell. These volcanic rocks are absent from the crest of the anticline, the erosion level here extending far below their plane of deposition. However, a narrow zone of porphyritic rocks extends across the peninsula of Canning Land from Doubletvigen to Aalborg Fjord along a fault which forms the eastern boundary of the Devonian beds.

Similar eruptives are also found on Wegener Halvø below the Devonian sandstones, thus at Kap Brown and in the central part of Fleming Fjord at the northern entrance to Trekegledal. Noe-Nygaard (1934) further reports an occurrence in the western part of Nathorst Fjord, in the eastern slope of Mt. Quensel, but without describing the stratigraphical position. Since then the place has not been investigated. It seems quite probable, however, that the eruptives there are not found below, but in the Devonian, and even in the Upper Devonian beds, thus occupying another stratigraphic position than the previously defined

volcanic Kap Fletcher Series. At the eastern foot of Mt. Quensel we encounter the continuation of the Ravnefjæld fault, while along another fault, running obliquely to the former, slightly upwarped Upper Devonian beds have been displaced so as to rest against highly folded Middle Devonian strata; thus the structural conditions in this area are evidently rather complicated. Possibly we are here concerned with intra-Devonian eruptives which can be compared with those of Moskusokse Fjord.

In the eastern regions of Canning Land the main part of the rocks of the volcanic Kap Fletcher Series were removed during various periods of erosion. The coarse rock fragments resulting from this denudation are present in large numbers in the basal conglomerates of the transgressive series of the Middle Devonian, the Carboniferous, the Permian, and the Trias. In order to explain this constantly repeated erosion of a sequence of rocks which at the present day only occurs *in situ* in a small area, it must be assumed that the rocks were originally distributed over a larger area. The thick Middle Devonian sequence of sandstones covered the greater part of them, protecting them from early denudation. Through the periodically repeated elevation of the eastern part of the Jameson Land block constantly fresh portions were later laid bare for erosion.

The occurrences of the volcanic Kap Fletcher Series visible at the present day on Canning Land and Wegener Halvø have been lowered through old, probably pre-Permian, faulting to a level below the later erosion surfaces. In this way minor fragments of the earlier volcanic structures were preserved, though with a somewhat disturbed bedding. In order to obtain a total picture, the observations made in the individual districts should be compared with each other and correlated. However, this would require even more detailed investigations in the field, measurements, and collections of rock samples.

In the following pages the geological conditions of the individual localities visited by me will be briefly described.

c. Porfyrfjæld.

West of the mountain of Kap Tyrrell, between Snevigen and Doubletvigen, there is an isolated occurrence of lava rocks and consolidated tuffs of the volcanic Kap Fletcher Series. It was discovered by NOE-NYGAARD and the area was called Porfyrfjæld. According to my observations the occurrence occupies an area of about 3.5 km^2. The porphyries have been faulted down, almost forming a graben. The graben rises rapidly towards the south, so that the porphyries crop out in the upper part of the southern slope of Porfyrfjæld, while to the north they dip down below Nathorst Fjord. On the map the occurrence is therefore surrounded by the Eleonore Bay Formation on three sides,

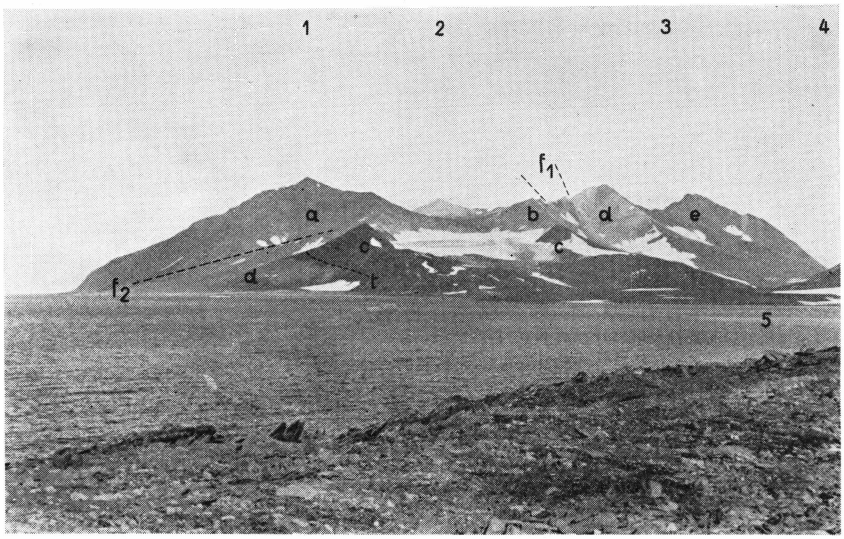


Fig. 11. Porfyrfjæld and Aarhus Bjærg, seen from the southwest.
Legend:
1 Porfyrfjæld, 2 Kap Tyrrell Bjærg, 3 Aarhus Bjærg, 4 pass leading from Doubletvigen to Aarhus Bugt.
a) Porphyries and tuffs of the volcanic Kap Fletcher Series.
b) Pyroclastic rocks of the base of the volcanic Kap Fletcher Series.
c) overthrust dark quartzites of the core of the anticline. They have been lowered by faults which separate them from Aarhus Bjærg.
d) Quartzites and limestones of the middle Eleonore Bay Formation.
e) Banded quartzites of the uppermost part of the quartzitic shales series of the lower Eleonore Bay Formation.
f_1) Faults in the east side of Porfyrfjæld.
f_2) Fault in the west side of Porfyrfjæld.

viz. on the east, south, and west. The margins of the uplifted blocks have been more intensely eroded than the hard porphyries of the intermediate block, the original relief having accordingly been reversed, the porphyries, owing to their hardness, rising above their surroundings.

On the west side of the small bay Snevigen the porphyries rise as a massive mass of rock, while on the east side of the bay the varicoloured beds of the Eleonore Bay Formation are clearly distinguishable in Kap Tyrrell Bjærg.

From Aarhus Bjærg a mountain ridge extends westwards to the southeastern corner of Porfyrfjæld. Here the Eleonore Bay Formation, which forms the crest of the mountain, is sharply separated by a fault from the volcanic rocks. In the northern slope of the ridge the pre-Cambrian rocks are well exposed in a longitudinal section. They comprise black shales alternating with light-coloured beds of the uppermost part of the series of quartzitic shales; they dip gently towards the north.

To the west, towards the fault zone, the quartzites have been bent down, and on the ridge appear the upper red shales, then varicoloured, predominantly yellowish beds, grey limestones, and a yellow band, that is, the same sequence of strata which is met with in Kap Tyrrell Bjærg (cf. fig. 12). Two steep, sharply marked fault planes, which converge towards the base and cut across the mountain ridge, cut off the beds of the multicoloured series. A mass of dark shales, which form a narrow syn-

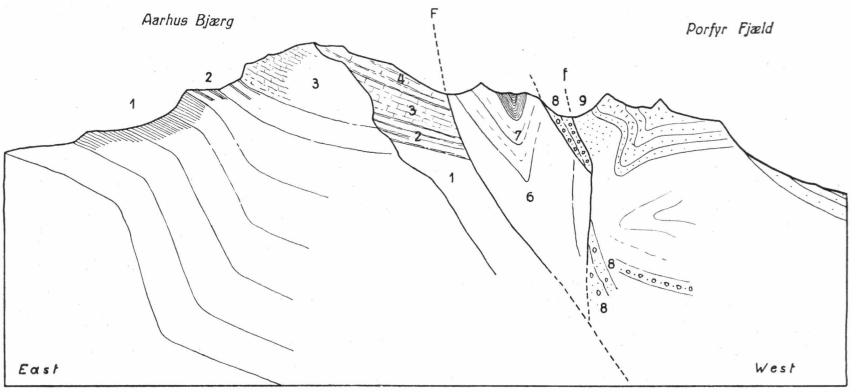


Fig. 12. Perspective sketch of the fault in the mountain wall leading from Aarhus Bjærg to Porfyrfjæld, drawn from Snevigen, from the north. (fig. 11 shows this fault (f_1) seen from the south).

Legend:

1) Red shales of the base of the middle Eleonore Bay Formation.
2) Intensely yellow-banded series.
3) Shaly limestones.
4) Series of beds varying in colour.

Nos. 1—4 are parts of the Multicoloured Series of the Eleonore Bay Formation, the numbers correspond to those in fig. 4.

6) Dark shales. Their stratigraphic position within the Eleonore Bay Formation could not be definitely determined.
7) Lighter-coloured limestones of the middle Eleonore Bay Formation with a small syncline of dark shales.
8) Breccias and conglomerates of the base of the volcanic Kap Fletcher Series. The bedding is highly disturbed owing to the fault.
9) Pyroclastic rocks: sandstones, volcanic tuffs, and beds of porphyries.

F, f) Faults. The main fault F is actually almost vertical.

cline, is squeezed in between the two fissures. Judging from their appearance they may be shales of the deeper part of the Eleonore Bay Formation which have been thrust up into the core of the anticline and subsequently lowered.

On the west side of the fault bedded conglomerates, reddish-brown on weathering, and arenaceous tuffs are adjacent to the pre-Cambrian shales. They are rather steeply tilted along the fault and exhibit some

fold-like crumpling (cf. fig. 12). To the west they are overlain by dark porphyries which turn brownish-red on weathering.

The fault-line extends northwards through the valley at the head of Snevigen, but it is concealed by screes and morainic material and by a glacier tongue. No doubt, however, it runs along the foot of the eastern precipice of Porfyrfjæld to the bay of Snevigen, whence it bends seawards in the direction of Kap Brown.

On the south side of the previously described mountain crest the fault is likewise distinctly traceable. It extends through a small watercourse towards the eastern end of the cirque bay of Doubletvigen (cf. fig. 11). The down-throw of the block with the porphyries may here be estimated at about 700 metres. To the north the throw must increase with the lowering of the trough. Where it wedges out towards the south could not be ascertained. In this direction the porphyries rise above the level of erosion. In the dark shales in the mountain south of Doubletvigen and beneath the thick covering of débris in the depression in front of them the course of the fault could not be definitely made out. Along this fault the conglomerates and sandstone-like tuffs can also be observed on the south side of the crest of Aarhus Bjærg. Westward they descend down below the porphyries which form the upper part of Porfyrfjæld.

On climbing the south side of Porfyrfjæld from the cirque bay, we first meet with black quartzites of the Eleonore Bay Formation, which form the southern margin of the volcanic series. The contact between the two series runs from the eastern fault westward past a broad cirque towards Nathorst Fjord. In this cirque the boundary line is concealed by a small glacier, while it is visible on either side of the small marginal crest of the trough. Along a fault-line here the conglomerates at the base of the porphyries are adjacent to the shales of the Eleonore Bay Formation. These shales are the lower dark shales of the upthrust southern limb of the Caledonian fold, which here probably forms the substratum of the volcanic series. The amount of downthrow along this oblique fault may be estimated at about 200 metres.

The best exposures are found in the west side of Porfyrfjæld along Nathorst Fjord. On following the coast north of the cirque bay of Doubletvigen, one at first encounters predominantly light-coloured stratified quartzites, which are highly fissured and exhibit a very irregular bedding. Then follow grey bedded limestones and yellowish-weathering dolomites. They dip about 30° towards the north-northwest. At the top of the cliff, about 100 metres above the shore line, lies the overthrust series of black quartzitic shales, which slope 10—15° towards the southeast. The subjacent limestones as well as the overthrust shales are cut off near the mountain by a steep fault inclined 75—80° towards the

northeast. On the slope a creek has exposed the fault plane, which forms the western boundary of Porfyrfjæld, along some distance. In the down-thrown block we find, at the base, conglomerates overlain by arenaceous tuffs and well bedded porphyries, weathering reddish, grey, or greenish. The top is formed by bedded, almost massive porphyries apparently of a deep reddish-brown colour. The volcanic Kap Fletcher Series forms almost a syncline in the graben. Its beds dip together with the graben along its longitudinal axis towards the north-northwest, so that in the north the capping porphyries are found at sea-level. Grey sills penetrate the grey limestones on the west side of the fault. The same sills are also met with east of the fault in the lower beds of the volcanic Kap Fletcher Series. The grey sills are evidently younger than the fault, for they do not seem to have been dislocated along it. A dark, steep basalt dyke pierces the limestones and the grey sills in the coast.

The throw of the fault on the west side of Porfyrfjæld cannot be determined with certainty, it being uncertain to what horizon of the middle part of the Eleonore Bay Formation the grey limestones along the coast should be referred. An indication is given by the overthrust black shales. Here they lie much deeper than east of Porfyrfjæld, so it must be assumed that the amount of displacement between the Eleonore Bay Formation, the adjacent blocks, and the volcanic Kap Fletcher Series of the graben is less along the western than along the eastern edge of the trough. We are here confronted with a fault-zone the western portion of which has subsided while a central block has been down-thrown so as to form a graben.

Stratigraphy.

NOE-NYGAARD (1937, p. 93) describes a rock sample from Porfyrfjæld as a pyroclastic sediment which is found in the ridge west of Aarhus Bjærg. Probably the rock sample is derived from the place in which the aforementioned eastern fault intersects the mountain chain. Here conglomeratic and arenaceous beds occur and can be traced in the south side of Porfyrfjæld westward to Nathorst Fjord as the substratum of the porphyries. The lowermost beds visible are well bedded breccias with fragments of very variable size which may attain a diameter of half a metre. The rock fragments are mostly sharp-edged, but also include rounded blocks. They are derived from the Eleonore Bay Formation, all zones of which are represented: light and dark-coloured hard quartzites, black and reddish shales, black and grey fine-grained and oolithic limestones, and yellowish dolomites. In addition isolated porphyritic, mostly rounded, blocks occur. NOE-NYGAARD (1937, p. 94) describes them as volcanic bombs. On the basis of a microscopic examination he states the matrix of the pyroclastic rock to be sandstone-

like, with only few pebbly components, with much felspar and some mica, red hæmatite grains, and a calcitic mass as cement.

The breccias assume a brownish-red colour on weathering, and in their patina and content of pebbles, with the exception of the porphyries, resemble the Devonian basal conglomerates of the northern regions. Here on Canning Land, however, they are probably in part volcanic loose material, mostly ejecta, which in the initial stage of the volcanic activity were ejected through dykes and vent eruptions. On the Kap Fletcher peninsula and in Hesteskofjæld, also, these breccias are met with in the same stratigraphic position, so it may be assumed that a fairly large land surface has been covered with the ejected products. The bedding and first of all the occurrence of rounded rock fragments suggest that the material has been re-deposited in water. In Porfyrfjæld beds of this basal breccia more than 50 metres thick may be observed. Their substratum is not visible. They are overlain by reddish, and then grey and greenish fine-grained rocks with a distinct bedding. In the field they would be called arkoses owing to the many fragments of disintegrated red felspar. From these deposits originates the heterogeneous agglomeratic rock, consisting of pyrogenic minerals, fragments of magmatic rocks, and sedimentary fragments, described by Noe-Nygaard from the south side of Porfyrfjæld. These beds are interbedded with grey and greenish porphyries, so the whole series of rocks, about 150 metres thick, may be characterised as tuffites with interbedded lava. The lava beds are reported by Noe-Nygaard (1937, p. 58) to be grey and green porphyries with or without quartz phenocrysts.

The sequence of strata can be best observed on the west side of Porfyrfjæld. The south side is less favourable for observation, since some thick grey sills, hardly distinguishable in colour from the adjacent rock, intersect the beds at acute angles. In addition a small fault cuts obliquely upwards and eastward across the mountain wall. According to the description by Noe-Nygaard (1937, pp. 42 and 43) the grey sills and dykes are granitoid rocks of porphyritic habit. However, from their position we must draw the conclusion that they did not intrude till after the subsidence of Porfyrfjæld and consequently they must belong to a much younger period of eruption than the volcanic Kap Fletcher Series. However, if we are to make a definite determination of the age, an accurate mapping of the dyke rocks and a detailed petrographic comparison with the rocks of the adjacent regions, for instance those of the Kap Simpson complex, will be required.

The top of Porfyrfjæld is occupied by the thick-bedded and massive porphyries. They are sharply intersected by ravines and seem to rest with a faint angular unconformity on the underlying tuffs. According to the description by Noe-Nygaard (1937) they are red and brown

porphyries with and without quartz phenocrysts of the group of rhyolite-trachylatite-rhyodazite and the latite-andalatite rocks.

The mountain massif of Porfyrfjæld represents a fragment of the cone of a volcano. It was lowered by trough-faulting and thus escaped complete denudation.

d. The Kap Fletcher Peninsula.

If from the head of Aalborg Fjord we follow Basisdal, which extends southwards across a low pass to Carlsbergfjord, separating the Kap Fletcher peninsula from the Devonian area of Hesteskofjæld, we will meet a steep fault at a distance of about one and a half kilometres from the sea. It cuts obliquely across the valley towards the south-southeast, then turns southeastward and crosses the Kap Fletcher peninsula to Carlsberg Fjord. Along this fault the down-thrown rocks of the volcanic Kap Fletcher Series border on the pre-Cambrian limestones which build up the eastern part of the peninsula. To the west other faults separate the tuffs and porphyries from the Devonian sandstones in the mountains south of Hesteskofjæld. In a step-fault the series are lowered towards the west, and the volcanic Kap Fletcher Series rests on a step of this fracture zone.

From the southern entrance to Basisdal a branch valley leads in a northeasterly direction to Aalborg Fjord. It is cut across at almost right angles by the fault, and the course of the fault can therefore be easily observed in its slopes. Moreover the valley cuts down almost to the base of the volcanic series, so its deposition on the Eleonore Bay Formation is revealed. In the north side of the valley, bedded black siliceous limestones of the upper Eleonore Bay Formation crop out some distance west of the fault. They dip 60° towards the southwest and are overlain by breccias and volcanic tuffs, which dip 30—35° towards the southwest. The breccias and tuffs here attain a thickness of 200—300 metres.

The breccias at the base of the superjacent volcanic series are distinctly bedded. The clastic material is derived from the limestones and quartzites of the Eleonore Bay Formation and exhibits diameters of up to 10 centimetres. Here, also, occasional blocks of porphyry may be found in the sedimentary material. The breccias are overlain by regularly bedded sandstone-like tuffs. A network of different dyke rocks pierces the beds. Porphyritic dykes penetrate the tuffs, in part at very acute angles, almost like sills; some vertical, grey, granitoid dykes are remarkable on account of their wall-like relief. They seem to be much fresher than the porphyries, though the basalt dykes are the youngest eruptives within the area.

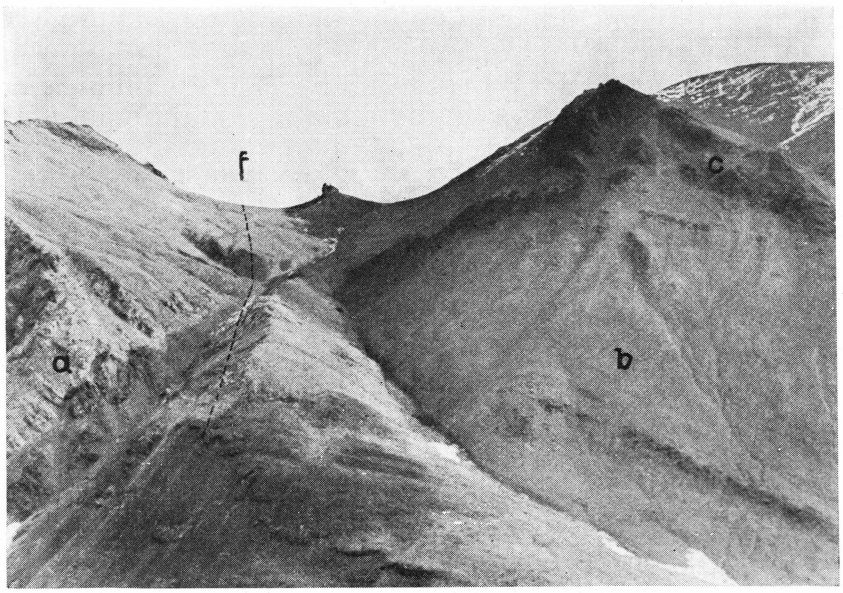


Fig. 13. Course of the large fault through the southern part of the Kap Fletcher peninsula, seen from the north.

a) Limestones of the middle Eleonore Bay Formation. They build up the eastern part of the peninsula.
b) Predominantly volcanic tuffs.
c) Porphyries of the volcanic Kap Fletcher Series.

In the south side of the small valley the course of the fault is very marked owing to the steep cliff formed by the eastern limestones against the tuffs. West of the fault plane, in the lower part of the slope, lie stratified volcanic tuffs, towards the top embedded with thick tongue-shaped beds of porphyry (cf. fig. 13). To the west the porphyries unite into a thick sequence of rocks which, forming a steep mountain mass, terminates the Kap Fletcher peninsula to the west. The porphyry masses are penetrated by some thick dykes, weathering red, which to some extent are intercalated as sills in the sequence of rocks. These dykes evidently belong to a later phase of the activity of the Kap Fletcher volcano. In fresh fractures they are distinguished by their large red felspars. These recur as clastic material in the sandstones of the Middle Devonian series.

In the small pass which connects the southern and the northern parts of Basisdal, bedded porphyries, in which a regular columnar structure can be recognised, are found. In between these effusive porphyries there occur shaly beds of fine-grained tuffs and coarse sands, which have, no doubt, been deposited in water.

The eastern part of the Kap Fletcher peninsula I have only seen from a distance. Nordenskjöld (1907) and Noe-Nygaard (1937) give only

brief descriptions of this region and some photographs. They show that the limestones and shales of the Eleonore Bay Formation are here penetrated by porphyry dykes and stocks, which stand out dark from the adjacent rock. As pointed out by NOE-NYGAARD, we are here confronted with the subvolcanic horizon, while the tuffs and porphyries in the western part of the peninsula represent a part of the supracrustal volcanic structure.

The succession of the volcanic series on the Kap Fletcher peninsula corresponds to that met with in Porfyrfjæld: At the base bedded breccias and tuffs, partly of volcanic partly of clastic origin, higher up intermediate porphyritic beds, and at the top massive eruptive porphyries pierced by porphyritic dykes of an intense red colour.

On the Kap Fletcher peninsula the unconformable superposition of the volcanic series on the Eleonore Bay Formation can be observed.

e. Porfyrdal and Hesteskofjæld.

The occurrence of rocks of the volcanic Kap Fletcher Series on the west side of Porfyrdal, along the eastern foot of Hesteskofjæld, is described and figured by NOE-NYGAARD (1937). This exposure of porphyritic rocks extends as a narrow band below the Devonian basal beds from the inner part of Aalborg Fjord to Nathorst Fjord. It established the connection between the Kap Fletcher area and Porfyrfjæld, across the western down-thrown part of the Caledonian anticline.

The Devonian sandstones are bounded on the east by Porfyrdal and its continuation towards Carlsberg Fjord, viz. northern and southern Basisdal. Where Porfyrdal cuts down through the rocks, a strip of the porphyritic substratum of the lowered Devonian strata is visible. The upper portion of the eastern slope of the northern part of Hesteskofjæld consists of Middle Devonian sandstone beds dipping regularly towards the west, in the lowermost third of volcanic Kap Fletcher rocks, and near the bottom of the valley the same black quartzites as build up the mountains of the middle portion of Canning Land in the east, crop out below them in some places. In this slope in Porfyrdal a normal longitudinal section, 4—5 km long, through the Devonian basal beds and the Kap Fletcher porphyries seems to be exposed. However, in the short transverse sections which are cut out in the creeks and in the coast of Nathorst Fjord faults can be observed to extend along the eastern boundary of the Devonian rocks parallel to or at acute angles with the strike of the beds, consequently they do not appear in the landscape and in the longitudinal section. As regards the stratigraphic value the exposure should accordingly be interpreted with great caution, as the series can

neither be observed in its total thickness or its normal stratification. Unfortunately I was unable to follow the course of these faults step by step.

At the northern outlet of Porfyrdal, at the foot of Hesteskofjæld, the contact between the Devonian and the volcanic Kap Fletcher Series is exposed in a short transverse section. This is the place in which G. SÄVE-SÖDERBERGH (1937, p. 9 et seq., fig. 1) collected fossils near the base of the Devonian series. The foot of the mountain slope as far as a rock ledge at a height of 110 m above sea-level is made up of massive porphyries

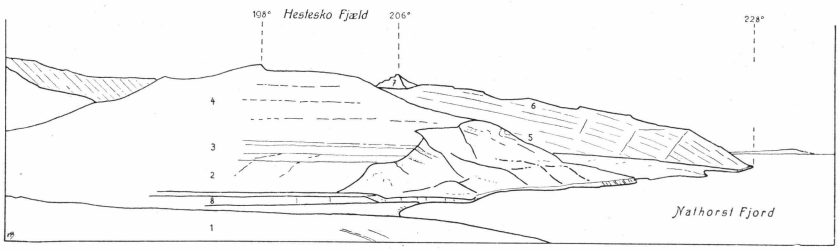


Fig. 14. The northern end of Hesteskofjæld, seen from the northeast.

Legend:
1) Quartzitic shales of the Eleonore Bay Formation.
2) Porphyries of the volcanic Kap Fletcher Series.
3) Basal series of the Middle Devonian (the *Heterostius* series of SÄVE-SÖDERBERGH).
4) Middle Devonian red series (the series with *Asterolepis* of G. SÄVE-SÖDERBERGH).
5) Greyish-greenish series of the Middle Devonian in the western slope of the mountain.
6) Banded series (the series with *Canningius Groenlandicus* of G. SÄVE-SÖDERBERGH).
7) Permian limestones, erosion remnant.
8) Young marine shore terraces.

weathering brown. In the west, towards the bedded Devonian rocks, they are cut off by a fault which runs parallel with the strike of the beds. Owing to débris the throw of the fault could not be determined, but probably it is not very great, though at least amounting to 100 metres. Along the fault the porphyries are adjacent to the Middle Devonian basal conglomerate. Nearly all the pebbles of this conglomerate are derived from the porphyries of the Kap Fletcher Series. They are weathering products of the volcanic rocks across which the Devonian basal beds transgressed. However, neither the base of the conglomerates nor their superposition on the porphyries can be directly observed in this place (cf. fig. 15). The two formations are separated from each other by the fault.

Down the eastern slope the porphyries can be traced almost as far as the bottom of the valley; but right down at the base they are covered by recent terraces. Farther inland, however, at the bottom of the valley, some beds of the volcano-clastic breccias and tuffitic sand-

stones are met with, striking almost in the direction of the valley and dipping towards the west. In the very bottom of the valley, in the neighbourhood, there occur black quartzitic shales which dip towards the northwest. They probably belong to the substratum of the volcanic series, though the contact itself cannot be observed. From the small visible thickness of the breccias and tuff beds it can be concluded that here, also, there is a fault plane between the quartzite beds and the tuffites along which the western wing has been somewhat lowered. The main fault probably runs through the valley, for judging from the altitude of the Devonian beds it must be assumed that a considerable lowering of the western regions has taken place.

Near Aalborg Fjord, in a rivulet at the foot of Hesteskofjæld, dark quartzitic shales interbedded with whitish and reddish quartzites are found *in situ*. The position of the beds is highly disturbed; several steep sliding planes intersect the shales. In some places the quartzitic beds are brecciated and re-cemented by a reddish matrix. Two perpendicular basalt dykes penetrate them in a north-northeasterly direction. They dip on an average 50° towards the southeast or east-southeast. The quartzitic series is here penetrated by a fault zone striking northeast-southwest. Up the slope, about 50 metres above the bottom of the valley, there occur bedded sandy tuffs dipping slightly towards the west, overlain by highly disintegrated massive porphyries. The boundary plane towards the quartzitic shales is covered with débris. Since no breccias are visible at the base of the tuffs, the possibility must be taken into consideration that the quartzitic shales and the volcanic series join each other along a fault plane, and that it is only apparently a normal superposition.

In Basisdal some distance south of the head of Aalborg Fjord two faults can be distinctly seen. Towards the south they move away from each other. On the intermediate block the volcanic series lies at the surface, while in the western block the Devonian sandstones form the surface of the land.

From the exposures of the volcanic Kap Fletcher Series in Hesteskofjæld we may draw the conclusion that here the volcanic rocks rest upon the quartzitic shales. They transgress across the eroded Caledonian fold. To the south, on the Kap Fletcher peninsula, the tuffitic beds and breccias overlie the limestones of the upper multicoloured series, along Hesteskofjæld they rest on the deeper quartzitic shales of the middle of the fold and in Porfyrfjæld on the upthrust quartzites above the limestones of the northern limb of the fold. From the course of the longitudinal profile it can be inferred that no great unconformity exists between the volcanic Kap Fletcher Series and the overlying Devonian rocks. The

great unconformity is found between the Eleonore Bay Formation folded in Caledonian time and the volcanic series.

f. The Region Around Kap Brown.

The surface of deposition of the Middle Devonian strata across the volcanic Kap Fletcher Series on Canning Land is nowhere well exposed. Hence the profile in the southeast side of the mountain of Kap Brown gives an unambiguous picture of these conditions. In favourable illuminations the reddish, distinctly bedded, Devonian rocks of the upper portion of the mountain, when seen from the south, are clearly distinguishable from the massive apparently greyish-brown porphyries at the foot of the mountain. It will be seen that the Devonian basal beds fill up the depressions in the rugged surface of the volcanic rocks, while the whole is covered by the upper Devonian beds. The Devonian deposits spread over a highly peneplaned slightly hilly volcanic landscape. Great unconformities exist in some places between the beds of the volcanic series and the Devonian sandstones. Thus in the south slope of the mountain of Kap Brown the porphyries strike almost east-west and dip 40—70° towards the north, while the overlying Devonian beds dip on an average 30° towards the north or northwest. However, if the volcanic supercrustal rocks of the Kap Fletcher Series are considered as one complex, it occurs as a conformable mass below the Devonian sandstones (cf. fig. 5).

In the eastern slope of the mountain of Kap Brown the Devonian beds and the underlying porphyries abut against a fault. East of the fault dark shales penetrated by light-coloured quartz dykes and quartzitic beds can be observed. I have only seen these rocks from the sea, but from their appearance I take them to be quartzitic shales of the Eleonore Bay Formation. Various observers found that at the northeastern point of the massif of Kap Brown the shales are penetrated by porphyritic dykes (Nordenskjöld 1907, Koch 1929, Noe-Nygaard 1934). In this place, as in the eastern part of the Kap Fletcher peninsula, it may be the question of the subvolcanic level, of porphyritic dykes which have penetrated into and through the Caledonian rocks.

On the south coast of Kap Brown, as on Canning Land, the volcanic Kap Fletcher Series has been lowered by faulting and thus protected against erosion. In the west it continues beneath the Devonian beds and crops out again in the neighbourhood of the expedition station Vimmelskaftet in the middle part of Fleming Fjord along the elevated edge of a block.

3. The Devonian Sandstone.

a. Coordination of the Devonian Occurrences on Canning Land and Wegener Halvø within the Devonian Formations of East Greenland.

The area between Gauss Halvø and Scoresby Sund is an ancient geological zone of depression, in the outer parts of which sediments have been deposited since the Devonian time, though with interruptions. Between Segelsällskapets Fjord and Waltershausen Gl. the depression continues westward right across the Caledonian folding chain and some distance into the Eleonore Bay Formation, in this region corresponding to an axial depression of the folds. Thus the Caledonian surface structures within the Eleonore Bay Formation were protected against erosion, and the Devonian molasses, also, were preserved in this depression zone.

From the northern part of Scoresby Land, from Kap Peterséns to some distance into Strindberg Land, the western boundary of the Devonian deposits is exposed as an ancient limit of transgression. Along an old steep rock wall extending in the direction north-south the Devonian sandstones, which may be termed late Caledonian molasses, rest unconformably upon folded beds of the Eleonore Bay Formation and Cambro-Silurian beds. However, the eastern boundary of the Devonian trough is unknown. In the east the Devonian deposits are cut off by the post-Devonian main fault; east of this fault line Devonian beds are only exposed in a few places. From Sofia Sund towards the southwest this large fault intersects the Devonian area as a diagonal fault and cuts across the western margin of the Devonian depression. Thus the Devonian area is divided into two parts: a northern area, in which the Devonian sandstones are found at the surface and cover a comparatively high-lying central block, and a more eastern and southern area, in which they have been lowered and parts of them have been covered with younger sediments.

The occurrence of Devonian beds on Wegener Halvø and on Canning Land was first described and mapped by NOE-NYGAARD (1934, 1937). On Wegener Halvø the Old Red Series is found to the east in the mountain of Kap Brown and to the west in Ravnefjæld and Quensel Bjærg. These two occurrences are separated by a graben, which is filled with younger sediments and extends right across the peninsula. On Canning Land the Devonian sandstones occupy the western part of the peninsula. According to the statements by SÄVE-SÖDERBERGH (1937) this occurrence corresponds to the eastern occurrence on Wegener Halvø.

Both on Canning Land and on Wegener Halvø the Devonian deposits are bounded on the east by old Caledonian sediments along

a fault. Towards the west, however, they disappear beneath younger rocks, which again dip towards the west, occupying the broad and shallow syncline of Jameson Land. Farther westward the overlying beds rise again towards the fault in Stauning Alper, and it might be expected that the Devonian beds, also, would crop out. From the maps of STAUBER (1942) and BIERTHER (1941), however, it would seem that they do not crop out again. Here the late Palaeozoic sedimentary series extend inland beyond the western boundary line of the Devonian deposits. Hence the western boundary of the Devonian, which in the northern Devonian area was found to run in a north-south direction, may probably be continued southwards from Kap Peterséns. The western boundary of the Devonian deposits would then extend somewhere beneath the Mesozoic basin of Jameson Land. To the south the western Carboniferous boundary of transgression intersects that of the Devonian approximately in the area of Syltoppene.

In Ravnefjæld on Wegener Halvø NOE-NYGAARD (1934) found some Osteolopid remains, which were described by SÄVE-SÖDERBERGH (1933) and determined as fossils of the upper Middle Devonian, corresponding to the Scottish Orcadian. However, NOE-NYGAARD did not succeed in correlating the Devonian series in the Kap Brown area and on Canning Land with those in Ravnefjæld. In his "Geologie von Grönland" (1935) KOCH likewise referred the Devonian beds of these two regions to the Middle Devonian. However, this stratigraphic coordination of the three areas was opposed by NOE-NYGAARD (1935, p. 494), nor did he, in his corrections of 1937, share KOCH's view. On the contrary, owing to analogies with the northern Devonian areas he maintains that these beds on Canning Land are of Upper Devonian age. The controversy was decided by SÄVE-SÖDERBERGH (1937, 1938), who on the basis of numerous finds of fossils demonstrated that in Ravnefjæld as well as at Kap Brown and on Canning Land we are concerned with upper Middle Devonian beds, and that the opinion held by KOCH was correct.

Southwest of Ravnefjæld and in Quensel Bjærg an upper Old Red series rests upon the folded Middle Devonian beds. With some reservation they were designated by SÄVE-SÖDERBERGH (1937) as upper Devonian.

b. The Devonian Sandstone Series on Canning Land.

A belt, four to five kilometres broad, of Old Red sandstones extends across the western part of Canning Land. The area covers about 39.5 km^2 and consequently constitutes more than one-fourth of the peninsula. On the east the Devonian deposits are bounded by a valley, which extends from Nathorst Fjord to the head of Aalborg Fjord and thence to Carlsberg Fjord. In accordance with the designations used by SÄVE-

SÖDERBERGH (1937) we call the various parts of this zone of valleys the northern and southern Porfyrdal and the northern and southern Basisdal.

In the southern area, in Basisdal, the down-thrown Devonian beds are sharply separated by a fault from the eruptives of the Kap Fletcher Series to the east; in the northern area, however, in Porfyrdal, the fault is less distinctly visible. However, in the transverse section in the coast of Nathorst Fjord it can be seen that here, also, the Devonian beds have been lowered in relation to the porphyries (cf. fig. 15). To the west, towards the level tract of Ituidlek, the Devonian sandstones dip with inclinations of 35—45° down beneath Carboniferous and Permian sediments.

On account of this lowering of the beds the superposition of the Devonian strata on the porphyries or on the Eleonore Bay Formation can hardly be seen on Canning Land. From the transverse sections in the north and south coasts it can only be ascertained that the Devonian beds have been lowered and abut on porphyries along the fault line. Across the land the exposures are situated parallel with the fault zone, so no normal superposition can be observed. The most favourable locality for investigation would seem to be Aalborg Bjærg, situated at the head of the fjord of the same name. Halfway up the southeastern wall of the mountain there is a crag which forms the western end of the Eleonore Bay limestones in the south side of Aalborg Fjord. Towards the interior of the mountain the limestones are cut off by a fault and abut on the lowered Devonian beds, which rest on rocks of the volcanic Kap Fletcher Series.

The best impression of the superposition of the Devonian series is obtained on Wegener Halvø, in the south side of the mountain of Kap Brown. The steep rock walls of the lower part of the mountain are sparingly covered with scree, so the structural conditions along the coast can be observed in a section of a length of about 2 kilometres (cf. fig. 5). The basal Devonian beds rest horizontally on obliquely tilted porphyry beds belonging to an eroded volcanic structure. The pre-Devonian land surface was traversed by minor shallow furrows. In the summer of 1936 I was unable to visit the north side of Wegener Halvø. No doubt good exposures of the surface of deposition of the Devonian sandstones on the volcanic rocks are found there. However, from the maps available so far no definite conclusions as to the structural conditions between the station of Vimmelskaftet and Tvekegledal can be drawn. At the northeastern point of Ravnefjæld, situated at the northern outlet of Tvekegledal, rocks of the Eleonore Bay Formation seem to occur beneath the Devonian beds. They are possibly penetrated by porphyry dykes and to the west overlain by extrusive rocks. The breccia which at Vimmel-

skaftet forms the base of the Devonian sandstones contains blocks of quartzite and fragments of porphyry. Since this region is intersected by several faults and crush breccias occur in the fault zones, the structural conditions are fairly clear. I only visited the locality at Vimmelskaftet at the end of November 1933 after a heavy snowfall; from the isolated exposures I was unable to obtain a satisfactory idea of the tectonic and stratigraphic relations.

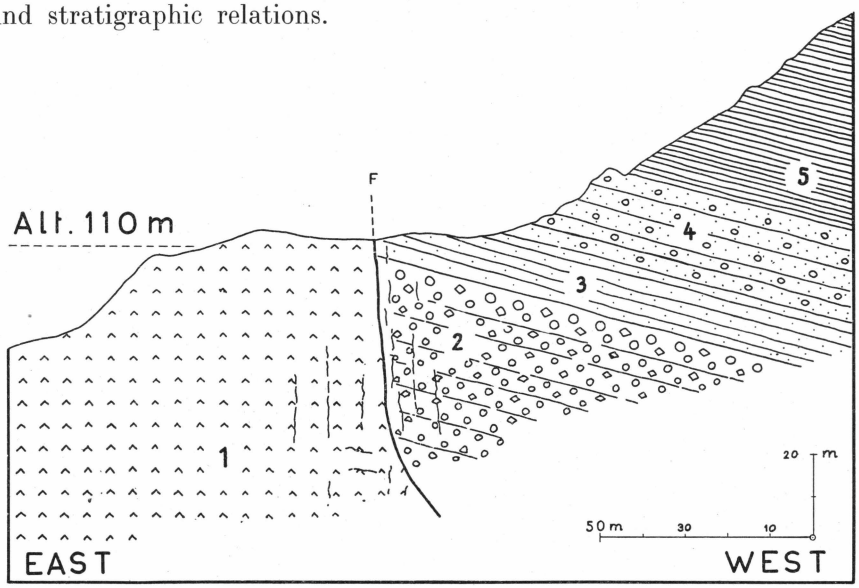


Fig. 15. Section through the base of the Devonian in the northeastern slope of Hesteskofjæld.

Legend:

1) Porphyries of the volcanic Kap Fletcher Series.
2) Devonian basal conglomerate.
3) Red-spotted arkoses.
4) Greyish-white coarse-grained arkoses with pebbles (*Heterostius* Series of SÄVE-SÖDERBERGH 1937).
5) Reddish-brown shaly sandstones (base of the series with *Asteriolepis Säve-Söderberghi*).

F) Fault.

(cf. fig. 14 and G. SÄVE-SÖDERBERGH, 1937, text-fig. 1, p. 10).

Stratigraphy.

The basal conglomerate of the Devonian series is exposed on Canning Land in the northeastern corner of Hesteskofjæld, west of Doubletvigen in Narthorst Fjord (cf. fig. 15). At an altitude of 110 m a terrace made up of massive porphyries projects from the mountain wall. Along a fault to the west these porphyries adjoin well bedded Devonian sandstones, which build up the upper part of the mountain. The sandstones are underlain by a coarse conglomerate, about 30 m

of which are exposed. The lowermost conglomeratic beds and the substratum are covered by débris. They must, however, be assumed to be the basal beds of the Devonian sandstone series.

The rock fragments of which the conglomerate is composed are mostly somewhat rounded. Some of them measure more than half a metre in diameter, though pebbles of the size of a fist or a head preponderate. The rock material is in the main derived from the volcanic Kap Fletcher Series. It consists of greenish-grey and brownish-purple porphyries, which are only little broken up and are, no doubt, derived from the substratum of the conglomerate. KLEIBER (1944) also observed occasional pebbles of the Kap Wardlaw granite and, at Kap Brown, gneisses and blocks of the Eleonore Bay Formation. This suggests that at the beginning of the time of deposition of the Devonian sandstones the Caledonian rocks in the surrounding area were not covered everywhere by the volcanic formations.

The Devonian section that can be measured in the north-eastern wall of Hesteskofjæld has been briefly described by NOE-NYGAARD (1937, p. 17). SÄVE-SÖDERBERGH (1937, p. 9 et seq., fig. 1) gives a detailed summary of the whole sequence of rocks which, issuing from this place, is traceable across the massif of Hesteskofjæld. On the basis of finds of fossils and the prevalent colour of the sandstones SÄVE-SÖDERBERGH divides the Middle Devonian of Canning Land into four series. I accept this classification without further modifications, as the series erected on the basis of the lithological characters of the rocks can be conveniently fitted in with it. SÄVE-SÖDERBERGH distinguished between the following four series, numbered from below upward:

4. A striated series of alternating grey and red sandstones with *Canningius groenlandicus*, *Tristichopterus* sp., and other *Crossopterygii*.
3. A chiefly grey sandstone series intercalated with occasional reddish beds.
2. Predominantly reddish-brown sandstones, above alternating with brown, red, and greenish beds, below mainly red shales. This series is characteristic owing to the presence of *Asterolepis Säve-Söderberghi*, *Crossopterygii*, and *Psilophyton*.
1. Greyish-white arkoses with *Heterostius* sp., *Homostius* sp., and *Thursophyton* sp.

   At the base: Basal conglomerate.

According to SÄVE-SÖDERBERGH the fossils found determine beyond objection the age of the beds to be upper Middle Devonian.

A section, somewhat more complete in the upper part, is found along the shore of Carlsberg Fjord between the porphyries of the Kap Fletcher

peninsula and the depression of Ituidlek. On the basis of the predominant colour of the rocks I there ascertained seven local series which can be readily inserted into SÄVE-SÖDERBERGH's classification. Along the coast I measured the following section from west to east, i. e. from above downwards:

g. Light-grey, coarse-grained, often somewhat reddish-coloured and bedded sandstones, frequently with cross-bedding. In the lower layers occasional pebbles of quartzite, quartz, and granite are embedded in the sandstones.

f. Alternating grey and red beds of shaly micaceous sandstones. This series extends from Kollenbjærg south-southeastward to Carlsberg Fjord.

e. A thick series of predominantly greyish-green micaceous sandstones. They are interstratified with a few red shaly beds and yellowish sandstones.

d. Shaly, chiefly brownish-red-coloured sandstones.

c. Bedded coarse-grained arkoses, coloured reddish by felspars, interstratified with brown shales. Embedded in them are isolated accumulations of red granite pebbles. At the base is a conglomeratic bed with pebbles of the size of a fist of grey Devonian sandstones, Kap Fletcher porphyries, and red granites.

b. Red shaly sandstones. They occur at the outlet of Basisdal.

a. Light-grey and whitish-yellow arkoses.

Series a corresponds to basal series 1 of SÄVE-SÖDERBERGH, b, c, and d to his series 2, e to his series 3, and f to his series 4. The basal conglomerate is not exposed. To the west the uppermost series of SÄVE-SÖDERBERGH is overlain by a higher-lying series of sandstones, designated g in the above section. It is absent in the northern part of Hesteskofjæld, since the overlying Carboniferous beds cut obliquely down through the Devonian beds from south to north (cf. fig. 17).

In the Devonian section that can be measured in the coast of Nathorst Fjord the sequence of strata is possibly incomplete for tectonical reasons. On either side of the flat talus cone at the outlet of Zirkusdal west of Doubletvigen various disturbances can be observed in the Devonian beds along the sea-shore. At the coast the sandstones change their direction from north-northwest to northeast and in places exhibit flexure-like, very steep dips, at angles of up to 80°, down to Nathorst Fjord. Probably part of the red series, No. 2 of SÄVE-SÖDERBERGH, has been cut off and is lacking in the coast section. Hence small wave-like folds occur farther westward in the grey series, causing repetitions of the beds in the coast section.

The thickness of the Devonian series in the southern part of Basisdal as far as the depression of Ituidlek amounts to almost 3000 metres. From this thick, chiefly fine-grained, sandy deposit it can be concluded that in upper Middle Devonian times Canning Land was situated in the interior of a large sedimentation area and that the Kap Fletcher eruptives and the pre-Cambrian formations in the eastern part of the peninsula were buried below a thick covering of sandstones. Only the basal conglomerate and the arkoses and sandstones of the lowermost series could obtain their material from the nearest surroundings. After the peneplanation and covering of the area the sand masses for the upper series must have been derived from more remote regions. In this southern area, in which the Devonian rocks are only exposed locally, we do not know the extension of the sedimentation area. The area of the present Liverpool Land was quite probably covered with Devonian deposits, the upheaval of the crystalline rocks not having taken place till after Middle Devonian times, and it must be assumed that the eastern areas supplying the sand masses lay outside the present outer coast. The western margin of the Devonian trough may be assumed to have extended some distance west of the centre of the present Jameson Land basin.

c. The Upper Devonian Beds on Wegener Halvø.

In the western part of Wegener Halvø, in Quensel Bjærg and the mountains north of Jamesondal, almost horizontally bedded whitish and reddish sandstones rest on highly folded Middle Devonian beds. (For the place-names the reader is referred to the geological map of NOE-NYGAARD, 1934, pl. 2). On the basis of a scale of *Holoptychus* found here SÄVE-SÖDERBERGH (1937) determined with reservation the age of these beds as Upper Devonian.

In the lower part of the series we find light-grey coarse-grained sandstones with conglomeratic beds. These contain rounded quartz and quartzite pebbles, in places also reddish granites and grey Devonian sandstones. They are overlain by reddish sandstones with interbedded reddish-brown shaly beds, while higher up, in Quensel Bjærg, chocolate-brown sandstones with intermediate grey beds predominate.

The Upper Devonian beds are overlain by marine Permian conglomerates and limestones. From the direction of strike of the beds in the south side of Ravnefjæld it can be concluded that near Fleming Fjord some kilometres west of Vimmelskaftet the Upper Devonian on the north side of the mountain must occur below the Permian beds. To the east, by analogy with the conditions on the south side of the mountain, this series may be separated by a fault from the Middle Devonian series.

d. The Structural Position of the Devonian Series.

As a whole the Devonian beds on Canning Land form a table dipping towards the west. The general strike is approximately north, 8—10° west, and the dip on an average 37° towards the west. However, the track of the beds from Nathorst Fjord to Carlsberg Fjord form a faint curve concave towards the east. The Devonian strata form a low warping which dips towards the west.

That the Devonian series of strata was affected by movements, is shown by minor undulations and gliding planes at different levels which indicate differential movements within this huge series of beds. However, the deformations were too weak to produce distinct folds in the short section through the Devonian beds.

Similar conditions are found at Kap Brown, whose Devonian beds form the northern continuation of those on Canning Land. The Devonian sandstones in the mountain of Kap Brown dip towards the northwest, towards Fleming Fjord. They are penetrated by various displacement planes, steep faults as well as flatter down- or upthrusts, and at various levels, especially near Fleming Fjord, minor folds and crumpling can be seen. Towards the west, near the fault forming the boundary of the Carboniferous, the Devonian shales flatten somewhat out. A more intensive folding of the Devonian beds in the Kap Brown region could not be ascertained.

In the western part of Wegener Halvø, however, a more intensive deformation of the Devonian sandstones is met with. In the autumn of 1936 I stayed for some hours in the region between Quensel Bjærg and Ravnefjæld. Unfortunately neither suitable air photographs nor detailed maps were at my disposal for utilisation of the sketches I made there. From Vimmelskaftet towards Quensel Bjærg some large folds can be observed in the Devonian beds in a section right across Wegener Halvø. In the northern slope of Ravnefjæld towards Vimmelskaftet the Middle Devonian sandstones dip approximately 50° towards the southwest. Beneath these dipping series of beds, Kap Fletcher porphyries and probably also beds of the Eleonore Bay Formation rise towards the northeast, towards Fleming Fjord, near the outlet of Tvekegledal. Towards the south, below the Permian limestones forming the summit of Ravnefjæld, the Devonian strata are fairly horizontal, while in the hills north of Jameson River they are steeply tilted towards the south. Thus the Middle Devonian beds form a syncline beneath Ravnefjæld, the axis of which strikes approximately west-northwest, rising somewhat in this direction. The almost horizontal Permian limestones overlie with a marked angular unconformity the eroded Devonian fold. In the river bed in the lower part of Jamesondal and in the tributary rivulets coming

from the northwest highly disrupted Devonian sandstones, folded discordantly into each other, appear in the river bed. The directions and pitch of the minor folds vary from place to place, the predominant direction being west-east to southwest-northeast. The rock is a shaly compressed sandstone series belonging to the core of an anticlinal fold. The folding picture recalls the anticlines in the Devonian rocks in Hudson Land and the highly wrinkled zig-zag folds in the Swedenborg chain on Geographical Society Ø. In the eastern part of Quensel Bjærg, at the south side of the valley, the Middle Devonian beds at the foot of the mountain likewise bear evidence of intense folding. Whether these beds belong to the Jamesondal anticline or represent a new folding element, could not be investigated. However, in a cross-section through the western part of Wegener Halvø a broad syncline could be ascertained in the middle and a complicated anticline in the southern part of Ravnefjæld. Both these folds strike approximately in an east-southeasterly direction, that is, obliquely to the longitudinal axis of the peninsula. In the coast section west of Vimmelskaftet, also, the unconformable superposition of the marine Permian beds on folded Devonian rocks can be distinctly observed.

To the east this zone of folded Devonian rocks in Ravnefjæld is cut off by a post-Triassic fault which crosses Wegener Halvø in the direction north-south, so its continuation towards the east is not visible. On the west it is also bounded by a fault. The western fault-line runs almost in a north-northwesterly direction. On this side the western block is lowered, and at the bottom of the valley of Jameson Flod highly folded Middle Devonian beds abut on slightly crumpled Upper Devonian strata. This western fault extends obliquely through the eastern part of Quensel Bjærg. The Permian limestones in the western part of Ravnefjæld have not been displaced by the fault, so here we must be concerned with a pre-Permian fracture.

The Upper Devonian rocks on Wegener Halvø exhibit much simpler structural conditions as compared with the Middle Devonian. They form broad flat anticlines and synclines, which can be traced right across Jamesondal. They strike in a north-northwesterly direction, that is, obliquely to the more intensive folds of the Middle Devonian beds. The Permian limestones form nearly horizontal beds on top of both the Middle and the Upper Devonian and pass without disturbances across the fault line which separates these two Devonian series. Thus we can here distinguish between two episodes of folding activity. One occurred in the time before the deposition of the Upper Devonian series, the other is younger, though older than the deposition of the Permian series.

Considering the small divergency between the directions of the folds of the Caledonian Canning Land anticline and the Devonian folds in

Ravnefjæld on Wegener Halvø we may ask the question whether the two folding activities were not associated in some respect. Unfortunately too few accurate and detailed measurements are available to warrant a definite statement in this respect.

e. Comparison with the Northern Devonian Areas.

It has already been mentioned that a geological depression is found between Gauss Halvø and Davy Sund, which depression, especially in the north, extends far westward beyond the Devonian area and into the area of the Eleonore Bay Formation. In this area of depression, cut through by numerous fjords, the huge Upper Devonian deposits are met with which dominate the landscape over vast stretches on Gauss Halvø and the islands south thereof. The bottom of the Devonian trough can here only be studied along its western margin; in the interior of the trough it is situated deep below sea-level, so we do not know what stratigraphic horizons form the base of the Devonian series. Along the northern margin of the zone of depression, north of Moskusokse Fjord, the deeper Devonian series crop out at the surface and are available for observation. Similar conditions are found in the south between Davy Sund and Liverpool Land. Here the Devonian rocks have been much elevated and exhibit, at the top, an upper Devonian series, succeeded by the upper Middle Devonian beds, underlain by the volcanic Kap Fletcher Series, consisting chiefly of volcanic Devonian rocks, and finally the Caledonian basement.

To the north, also, the deepest series are probably of Middle Devonian age. In respect to facies very great similarities exist between the lower Old Red Series on Hudson Land and those on Canning Land. It may be assumed that the Middle Devonian beds on Canning Land continue northward at deeper levels to appear again in the lower Devonian series on Hudson Land.

To the north, as to the south, these lower series have been intensely folded locally, but the directions of the folds within the two areas do not agree. However, this is also the case with the directions of the Caledonian folds. But the slightly undulating folds in the Upper Devonian series in the western part of Wegener Halvø strike towards the north-northwest and agree approximately with the directions that can be observed in the folds of the Upper Devonian series on Ymer Ø and in Swedenborg and Kongeborgen along Kong Oscars Fjord. These folds were found to have arisen in Upper Devonian or early Carboniferous times. (Bütler 1935.)

4. The Carboniferous Series.

a. General Remarks.

In the western part of Canning Land Carboniferous conglomerates and sandstones rest upon Middle Devonian beds. In the geological literature dealing with East-Greenland the corresponding formations have been called continental Carboniferous. These beds are exposed in Kollenbjærg and in the northwestern slope of Hesteskofjæld. In the northern continuation of these occurrences lie the Carboniferous deposits on Wegener Halvø in the region around Calamites Dal.

The continental Carboniferous beds on Canning Land were first observed by KOCH (1929, p. 92) in the autumn of 1926, their Carboniferous age was shown beyond doubt by SÄVE-SÖDERBERGH (1937) through the finding of fragments of trunks of *Asterocalamites*.

b. The Occurrence of Carboniferous Rocks in Kollenbjærg.

A good idea of the superposition of the continental Carboniferous on the Devonian beds is provided by the section in the northwest side of Kollenbjærg. The locality was described and figured by SÄVE-SÖDERBERGH (1937), so I shall merely give some few particulars.

At the base of a greyish-white coarse-grained sandstone series found in the west side of the mountain, a conglomeratic bed is met with which rests unconformably on Middle Devonian sandstones. In this place the Devonian beds strike south 36° east and dip 45—50° towards the southwest. The overlying Carboniferous beds, however, strike south 10—20° east and dip 30—35° towards the west. Between the substratum and the overlying beds there is an angular unconformity of about 20—25° (cf. figs. 16 and 17).

The basal conglomerate of the Carboniferous series contains pebbles of varicoloured hard quartzites, as found in the Eleonore Bay Formation, porphyries of the volcanic Kap Fletcher Series, and Devonian sandstones. The finer clastic material includes many reddish felspars which are undoubtedly derived from the Kap Fletcher porphyries; the cement of the rock is carbonaceous. On top of the conglomerate follow light-grey, white, and yellowish coarse-grained quartzitic sandstones, which are somewhat micaceous and poorly cemented. These beds contain thin, easily crumbling coal seams. Above follow, in the southwest side of Kollenbjærg, other conglomeratic beds. They contain the same kind of pebbles as the basal beds. In this place these higher-lyings Carboniferous conglomerates are overlain by the more slightly westward dipping coarse breccias of the base of the Permian limestones.

In the sandstones SÄVE-SÖDERBERGH found two fragments of trunks of *Asterocalamites scrobiculatus*; he is of opinion that the rocks are probably Lower Carboniferous, i. e. Dinantian. The higher-lying conglomerates, which he met with west of Kollenbjærg, might according to his view form the base of the Namurien, which is likewise represented in East Greenland by continental deposits. Since, however, the thickness of the sandstones is inconsiderable, I do not think that the high-lying conglomerates represent a new horizon of the Carboniferous deposits.

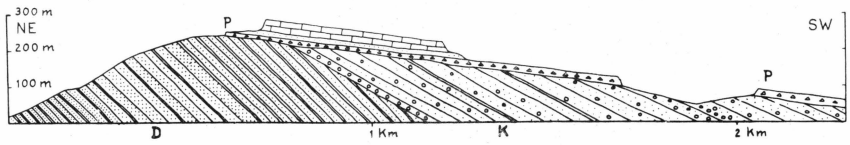


Fig. 16. Section through Kollenbjærg.

D) To the left: Middle Devonian.
K) To the right: Continental Carboniferous.
P) Permian-Zechstein: a) Basal breccia.
b) Fossiliferous beds.
c) Limestones.

The continental Carboniferous beds are overlain unconformably by the basal conglomerate of the marine Zechstein series, which forms the summit of Kollenbjærg.

c. The Carboniferous Beds in Hesteskofjæld.

Walking along the coast northeastward from Kollenbjærg, you will observe, above the Middle Devonian sandstones in the northwestern slope of Hesteskofjæld, a conglomerate which resembles the Carboniferous basal bed in Kollenbjærg described above. It rests unconformably on its Devonian substratum. Its pebbles are somewhat larger than in the locality first described. On top of the conglomerate follow again whitish-yellow poorly cemented sandstones, which occur at sea-level along a great distance and extend as a constantly narrower tongue up the slope as far as the crest. On account of the abundant covering with scree the boundary cannot be sharply drawn. However, seen from the sea the light-coloured Carboniferous sandstones stand out distinctly against the darker Middle Devonian rocks.

This occurrence of Carboniferous beds in Hesteskofjæld lies fairly accurately in the strike of the Carboniferous beds in Kollenbjærg. It appears from the mapping that the Carboniferous beds cut obliquely through the Devonian series, even so that to the north and east they rest upon deeper-lying Devonian beds. For this reason the upper part of

the Devonian section in Carlsberg Fjord is more complete than that in the coast cliffs of Nathorst Fjord (cf. fig. 17).

d. Wegener Halvø.

The Carboniferous beds on Wegener Halvø were only observed by me along the shore of Nathorst Fjord and only from a motorboat. West of Calamitesdal the Carboniferous sandstones are overlain by Permian beds, but here the unconformity seems to be somewhat less marked than in Kollenbjærg. The base of the Carboniferous series—as appears from the maps of NOE-NYGAARD (1934) and SÄVE-SÖDERBERGH (1937)—lies below sea-level. On the east the sandstones are separated from the Devonian beds of the Kap Brown region by a fault which runs east of Calamitesdal. The original structural relations between the Devonian and the Carboniferous beds cannot, accordingly, be observed here.

In the western part of Wegener Halvø no Carboniferous beds have been found so far. Possibly, however, such beds may be found on close investigation in the upper part of Jamesondal west of Quensel Bjærg. The Middle Devonian is there overlain by Upper Devonian beds. It would be very desirable to know how the Carboniferous beds overlie the Upper Devonian beds, whether there is an unconformity between them or whether they overlie each other without any disturbances. The places in which the superposition of the Carboniferous beds, especially the Dinantian, on the Devonian in the interior of the Carboniferous depression can be observed are so few that each new locality for observation would supply valuable results.

In the western part of the Jameson Land syncline the Carboniferous beds rise again and along the large post-Devonian main fault bounds on the Caledonian rocks. No doubt they continue westward from Canning Land and Wegener Halvø beneath the Triassic beds on Jameson Land, as indicated in STAUBER's sections (1942). It must be assumed that westward from Kollenbjærg they first overlie Middle Devonian, then Upper Devonian, and finally, from the concealed western margin of the Devonian depression as far as the large post-Devonian fault in Stauning Alper, Caledonian rocks. At how great depths the deposition plane of the Carboniferous rocks east of Canning Land intersects the Middle Devonian and Caledonian series, cannot be estimated from the observations available so far.

e. General Comments on the Occurrence of Carboniferous Beds in Nathorst Fjord.

From the geological maps of East Greenland published by various authors during recent years it appears that the continental Carboniferous

rocks occur along the post-Devonian fault to a breadth of 5 to 25 kilometres from Clavering Ø to some distance into the region around Scoresby Sund. They are bounded on the west by this fault line and along it, to the south and north, in Scoresby Land and on Clavering Ø, they adjoin Caledonian rocks, while in the middle, on Traill Ø, Geographical Society Ø, Ymer Ø, and Gauss Halvø, they rest against Devonian sandstones. On the whole the fault line forms the western boundary of the extension of the Carboniferous rocks. The eastern boundary, however, is unknown. North of Moskusokse Fjord the Carboniferous series wedges out towards the east. Here the eastern boundary, as pointed out by VISCHER (1943), is an erosion limit along the elevated parts of the blocks. It is remarkable, however, that the Carboniferous beds do not appear again in the deeper down-faulted portions of the outer blocks to the east.

VISCHER (1943, p. 178) assumes that the appearance of Devonian and Carboniferous rocks on Wegener Halvø and Canning Land at such great distances from the western margin of the Jameson Land block can be traced back to an early fault, i. e. to a downthrow of the beds. Only in this way may they have avoided the erosion on the elevated side of the block. It should, however, be borne in mind that the Carboniferous beds in the large depression zone south of Franz Josephs Fjord, unlike those in the regions of Clavering Ø and Hudson Land, dip towards the east and disappear beneath a covering of younger beds. In the southern area of distribution the Carboniferous accordingly extends much farther eastward than in the northern area. Where the depression terminates in the south and the beds rise, the deeper series must be visible again.

Like the Old Red molasse series, the continental Carboniferous sandstones were deposited in an elongated depression. The post-Devonian main fault forms their western margin. Unfortunately no studies are available so far which give a comprehensive picture of the structural relations of the Carboniferous series. Minor areas have, however, been investigated by varous geologists from different points of view, personally I have only in a few places extended my geological mapping beyond the eastern boundary of the Devonian series.

If by the aid of the different maps a longitudinal section is drawn through the belt, 350 kilometres long, of Carboniferous deposits, approximately the following divisions will be found: To the north, on either side of Godthaab Golf, there was a local depression during the Upper Carboniferous time. During the Namurian period it was filled with conglomerates and sandstones. Approaching this Carboniferous area from the south, from Moskusokse Fjord, we encounter the first Upper Carboniferous beds as thin horizontal sandstone sheets covering the top of the plateau of Salève Bjærg in Hudson Land at an altitude of almost 1000 metres above sea-level (BÜTLER 1940, pls. 1 and 2). They rest uncon-

formably on folded Devonian beds and quartzites of the Eleonore Bay Formation and are bounded on the west by the large post-Devonian fault. To the north the Carboniferous surface of deposition descends to 200 metres at Storelv and below sea-level in Godthaab Golf. The beds in Passagebjærg and the Carboniferous beds on Clavering Ø, which rise slightly towards the east, constitute the northern continuation of the sandstones found in the plateau at the top of Salève Bjærg. North of Clavering Ø the bottom of the depression rises again above sea-level and the Carboniferous rocks filling it wedge out. The deepest point of this depression filled with Upper Carboniferous deposits is found in the region around Godthaab Golf, where the Carboniferous deposits attain a thickness of more than 1000 metres. The sections and descriptions by SÄVE-SÖDERBERGH (1934) and VISCHER (1943) give a clear account of these conditions.

In the area south of Salève Bjærg a transverse ridge was probably found during upper Carboniferous times in the elongated depression which extended southward along the post-Devonian fault. The depression was deeper and broader south of Franz Josephs Fjord. In this southern part sandstones were constantly deposited since Lower Carboniferous times, accordingly the Carboniferous series are more completely developed here than farther northward. The deepest point of this southern depression is almost found where it crosses Kong Oscars Fjord. On either side of the fjord the Carboniferous molasse formation is nearly 2000 metres thick, and the Dinantian is overlain conformably by Namurian beds.

The Lower Carboniferous depression originally extended across Gauss Halvø northward to some distance into Hudson Land. On either side of the inner part of Moskusokse Fjord, in Gästisdal and Prospektdal, Dinantian beds have been down-faulted so as to form a narrow trough. On Gauss Halvø this trough was found to be of pre-Permian age.

From the stratigraphic determinations available so far it appears that the Namurian deposits within the northern area, that is, north of Moskusokse Fjord, transgressed over on Caledonian and Devonian series in a depression formed in Upper Carboniferous times, while south of Franz Josephs Fjord they rest conformably on Dinantian rocks.

The two regions, the northern and the southern, differ also in the transverse sections. To the north the Carboniferous beds with the tilted blocks rise eastward, and according to VISCHER (1943) they were removed by erosion in the elevated parts of the blocks even before the Permian time. The Carboniferous beds occupy a belt only 30 kilometres broad, at the most. In the southern area, where the Lower Carboniferous deposits have been ascertained, they descend towards the east and desappear beneath younger deposits (cf. STAUBER 1942, pl. 5). The ex-

posures on Wegener Halvø and Canning Land show that in the region of Kongebugten, as described by KOCH (1929), the beds continue at deeper levels to the outer coast and accordingly at the present day have a width of at least 70—80 kilometres. There is nothing to indicate that in these places we should be near the original eastern margin of the Carboniferous trough. The southern Lower and Upper Carboniferous depression was at first much broader than the narrow Namurian furrow in the region of Godthaab Golf.

The western margin of the Carboniferous depression, both the northern and the southern part, is formed by large faults: from Clavering Ø to Franz Josephs Fjord by the post-Devonian main fault observed by VISCHER, which intersects the Devonian structures at an acute angle, from the eastern part of Ymer Ø to the southern point of Kongeborgen on Traill Ø by a diagonal fault which cuts obliquely across the Devonian deposits, and in Scoresby Land by the fault in Stauning Alper, which bounds the high-lying Caledonian on the east. West of these fault lines no undoubted occurrence of Carboniferous rocks has hitherto been ascertained. SÄVE-SÖDERBERGH (1934) points out that there is a possibility that in Celsius Bjærg in the eastern part of Ymer Ø and in the southern part of Gauss Halvø the uppermost determined Devonian beds west of the fault may be covered by Carboniferous deposits. On top of the Arthrodire sandstone there he found another Upper Sandstone Complex belonging to the last sedimentation cycle within the East Greenland Old Red. However, the Carboniferous age of this complex has not yet been demonstrated, so it cannot be definitely decided whether the uppermost Upper Devonian is there overlain by lower Carboniferous, or whether we are here concerned with a still higher Devonian horizon. The beds designated as continental Carboniferous determined stratigraphically through the finds of fossils, represent a sequence of sedimentation which began with conglomeratic beds and differs from the Devonian one. Unfortunately the superposition of the Dinantian rocks on their substratum can only be observed in a very few places. These continental Carboniferous deposits extend westward to the large fault; they are not found beyond the fault line, which must accordingly be regarded as a limit of sedimentation. On the other hand, however, the Carboniferous beds exhibit stratigraphical disturbances in many places along this fault which suggest large post-Carboniferous vertical displacements. It must therefore be assumed that the movements along the fault line set in approximately at the beginning of the deposition of the Carboniferous beds, to the south and in the middle part in Dinantian times, to the north in Namurian times. The great thickness of the Carboniferous beds near Godthaab Golf and in Kong Oscars Fjord tell in favour of this explanation.

In Skeldal in northern Scoresby Land very coarse clastic rocks predominate in the deeper-lying Carboniferous strata along the margin of the Carboniferous area bordering on Syltoppene and Stauning Alper. In the deepest conglomerates exposed here blocks with a diameter of more than 50 cm can be met with. Clastic material derived from the immediate neighbourhood west of the fault is predominant, especially such as is derived from the various horizons of the Eleonore Bay Formation. Towards the top the composition of the contents of pebbles grow more uniform; white quartz pebbles mixed with occasional crystalline boulders which must have been transported over a somewhat greater distance predominate. In the deeper beds remarkable dragging and steep tilting can be observed near the fault, while such are much less marked in the upper Carboniferous beds. From the observations in the field, though somewhat incomplete, we may draw the conclusion that the continental Carboniferous conglomerates and sandstones were deposited along a fault-scarp, the origin of which dates back to Carboniferous times, but along which dislocations took place even in post-basaltic time.

From the eastern part of the southern Carboniferous depression, with the exception of Canning Land and Wegener Halvø, no Carboniferous exposures are known, and we do not know the character of the substratum of the trough. Only the sections in Kollenbjærg and Hesteskofjæld show that Middle Devonian rocks were also present at the bottom of this depression, that the Dinantian deposits spread transgressively and unconformably across them, and that the Carboniferous beds farther eastward probably rest on older series. Evidently the broad Devonian trough continues south of Kongeborgen in the direction north-south, as observed farther northward, towards Jameson Land below the Carboniferous basin, and the deposits filling it appear as windows on Wegener Halvø and Canning Land. The longitudinal direction of the Carboniferous basin is oblique to that of the Devonian trough. South of Kong Oscars Fjord, in Scoresby Land, the Carboniferous rocks spread westward beyond the old Devonian boundary, in Skeldal bordering on the sub-Cambrian tillites and the Eleonore Bay Formation, and along Schuchert Elv against Caledonian crystalline rocks. The deepest depressions of the two troughs do not correspond to each other. The Devonian trough has its greatest axial depression in the region around the outer Franz Josephs Fjord, that of the Carboniferous depression is situated south of Kongeborgen near Kong Oscars Fjord.

In the above some general regional questions concerning the continental Carboniferous series have been dealt with in order that problems which should be further investigated may be made the subject of discussion. In order that definite conclusions may be drawn, the observations hitherto made should be supplemented by a systematic investiga-

tion along the western boundary line of the Carboniferous. Transverse sections should be measured systematically from uniform points of view throughout the whole length of the Carboniferous depression.

5. The Permian Series.

a. General Remarks.

In Kollenbjærg in the western part of Canning Land the obliquely tilted Devonian and Carboniferous sandstones are overlain by a more horizontal sheet of Permian conglomerates and limestones. Another outlier of Permian deposits is found farther eastward on the mountain ridge of the western part of Hesteskofjæld. West of Kollenbjærg the Permian rocks form a continuous inclined table, which dips westward down below the Triassic beds in Nordenskjöld Bjærg. In the depression of Ituidlek, however, they are covered by Quaternary deposits. On Canning Land the area east of the depression occupied by Permian deposits measures about 4.5 km².

The Permian limestones in the region around Nathorst Fjord were discovered by LAUGE KOCH (1929). He took them to be of Upper Carboniferous age, at any rate the lower and middle portions, the so-called *Productus* limestone. The beds on Depot Ø immediately subjacent to the Triassic beds in Nordenskjöld Bjærg he determined to be Permian. Later on the late Palæozoic marine limestones along the east coast of Greenland were termed Permo-Carboniferous. KOCH (1929, p. 92) writes that the Carboniferous sandstones on Canning Land are probably overlain by Upper Carboniferous *Productus* limestones.

The age of the Permo-Carboniferous limestones has subsequently been much discussed. In his paper from 1937 (pp. 19, 21) NOE-NYGAARD, in agreement with the view held by FREBOLD (1931, 1938), describes them as undoubted Lower Permian. However, already in 1935 ALDINGER pointed out that the fish fauna of the *Posidonomya* shales, an intermediate bed in the marine limestones, has a similar composition to those of the German and English Zechstein series and accordingly could not differ very much from these in age. He therefore placed the Greenlandic series fairly high up in the Permian system. MAYNC (1942) on the basis of a comprehensive work in the field cleared up the stratigraphy of the East-Greenland Permian and i. a. established that the various divisions of the Permian section vary in a horizontal direction and that accordingly the various horizons distinguished in the Permian sections occupy no constant level, but are local facies formations. The reef limestones and dolomites met with in several places in East Greenland at the base of the Permian series were determined by MAYNC to be Zechstein forma-

tions corresponding to the Kungur-Kazan horizon of Russia. According to the stratigraphic table on which the coordination is based, the basal beds of the East Greenland Permian can be termed Middle Permian or lower Upper Permian. As regards the Depot Island Formation defined by KOCH (1929) MAYNC agrees with the conclusion drawn by SÄVE-SÖDERBERGH that these beds should be referred to the uppermost Permian. MAYNC even describes them as Permian deposits corresponding to the uppermost Permian horizon in the Tethys.

All investigators of the East Greenland Permian agree that it comprises littoral-neritic formations which were deposited in shallow water. The marine Permian deposits attain only an inconsiderable thickness as compared with the continental furrow and trough-deposits of the Devonian and Carboniferous systems.

b. The Permian Deposits in Nathorst Fjord.

The localities in which Permian rocks occur on Canning Land are described in detail by SÄVE-SÖDERBERGH (1937), so the reader is referred to his descriptions. The Permian table in Kollenbjærg dips about 10—15° towards the west, forming an angular unconformity with the underlying Carboniferous sandstones of 20—25°, and with the Middle Devonian beds of 35—40°. On a rough transgression surface rests, at the base of the Permian, a reddish-brown-weathering breccia of varying thickness. The clastic material of the breccia is angular, sharp-edged, and includes various quartzites and limestones of the Eleonore Bay Formation, reddish granites and gneisses are also represented, and further porphyries of the volcanic Kap Fletcher Series, and Devonian and Carboniferous sandstones. In some places the Devonian material predominates. Occasionally blocks and slabs of slate up to one metre long may be met with among the rock fragments. No doubt we are here confronted with a rock made up of local detritus which has accumulated in the depression of the transgression surface. This can be distinctly observed in the western part of Wegener Halvø, where the Permian basal breccia is occasionally absent on the elevated parts of the substratum. At the top of Kollenbjærg the dolomitic limestones form an isolated bed of a thickness of about 20 metres. As stated by NOE-NYGAARD (1937), the basal breccia extends farther southward and westward. Owing to the size of the rock fragments and the inconsiderable inclination of the beds the Permian breccia is well distinguishable from the underlying conglomerates of the continental Carboniferous series.

Only the lower portions of the Permian deposits are preserved on Canning Land. In the depression of Ituidlek the middle and upper portions are covered by Quaternary deposits and the talus at the foot

of the eastern slope of Nordenskjöld Bjærg. It is only on the small Depot Ø in the western part of Nathorst Fjord that the uppermost Permian rocks crop out. Probably they may also be met with on the promontory south of the island at the northern end of Nordenskjöld Bjærg.

Exposures more favourable for a study of the Permian stratigraphy are found on Wegener Halvø. In the regions around Ravnefjæld and

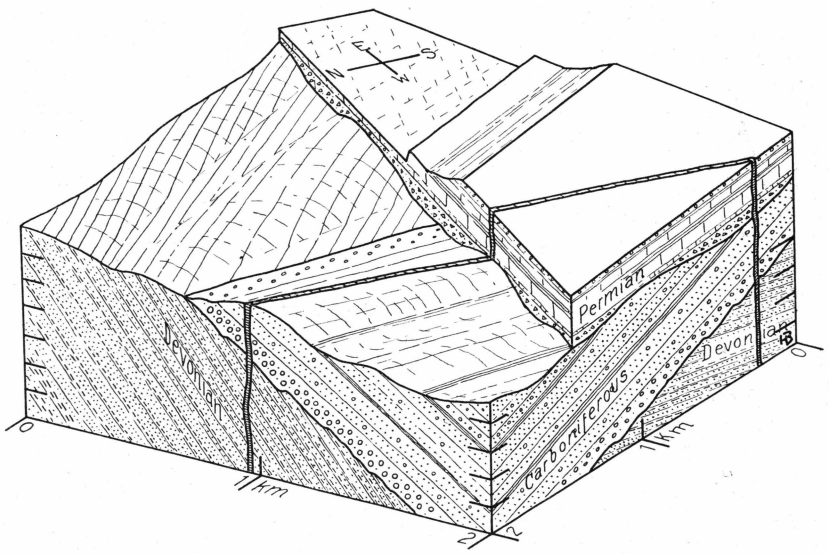


Fig. 17. Diagrammatic representation of the structural position of the Middle Devonian, the continental Carboniferous, the Zechstein, and a basalt dyke in the region around Kollenbjærg. Construction on the parallel perspective.
To the left the Permian series is assumed to be denuded, to the right to be reconstructed.

Quensel Bjærg the Permian rocks from continuous bands and summit plateaus, while farther east they are well exposed and easily accessible in a long coast section exposed from the basal beds to the lower limit of the Trias.

The total thickness of the Permian deposits in the region around Nathorst Fjord varies approximately between one and two hundred metres. Even the basal breccia exhibits a highly varying thickness. SÄVE-SÖDERBERGH (1937) states that in Kollenbjærg its thickness decreases from west to east from 20 to 8 metres, while still farther eastward, in Hesteskofjæld, the Permian limestones, according to his observations, rest immediately on Middle Devonian rocks. Similar observations may be made on Wegener Halvø. In the south side of Ravnefjæld the conglomerates, reddish-brown on weathering, can be seen

below the limestones at the top. They almost wedge out towards the west, to increase in thickness again still farther westward. In Quensel Bjærg, also, the reddish-brown conglomeratic band can be seen below the limestones. In the north side of the mountain it decreases in thickness, and in a locality visited by me it was replaced by a bed, about 5 metres thick, of arkose sandstones brown on weathering. The thickness of this Permian basal bed varies from 0 to 30 metres.

In Kollenbjærg the conglomerates are overlain by a bed, 3 metres thick, of somewhat sandy limestones, weathering yellowish-brown. According to SÄVE-SÖDERBERGH it constitutes the basal bed of the Permian in Hestoskofjæld. On disintegration of these beds a large number of fossils are laid bare. The series continues upwards with dolomitic limestones weathering grey, which forms a steep cliff throughout the region of Nathorst Fjord. In Kollenbjærg these limestones are distinctly bedded, though still only 15—20 m thick, while in Hesteskofjæld, according to SÄVE-SÖDERBERGH, they are 50 m. In both places the beds are erosion remnants, the upper part of the Permian series having been removed by erosion.

On Wegener Halvø, however, the Permian strata are mostly overlain by Triassic beds, so the whole Permian section can be measured there. NOE-NYGAARD (1934, p. 34 et seq.) describes two fairly complete sections from the region around Vimmelskaftet and Paradigma Bjærg; however, since he only states the altitude at which the measurements were made, the exact thickness cannot be made out. According to his statements the dolomites in the lower part of the Permian series are overlain by about 100 metres of predominantly calcareous shales with limestone-dolomite beds in the uppermost part. On top of these NOE-NYGAARD lets the Eotrias begin with a conglomerate in which rolled Permian fossils are to be found. Then follow arenaceous mouldering grey shales, which contain *Ophiceras* and *Pseudomonotis*.

The varying thickness of the dolomitic limestones at the base of the Permian series on Wegener Halvø is very remarkable. Their thickness seems at first to increase from west to east, to reach its maximum, about 100 metres, in the region around Ravnefjæld, whence it decreases eastward to about 30 metres in Calamitesdal. In the area in which the thickness is greatest the limestones are massive, being reef formations; with the decreasing thickness a distinct bedding appears again.

c. The Position of the Depot Island Formation.

On the peninsula of Canning Land the shaly beds overlying the basal dolomites have been removed by erosion. To the west, in the depression of Ituidlek, they are covered by Quaternary deposits. The uppermost

Permian beds appear in some places below the Triassic beds of Nordenskjöld Bjærg: at the shore in the northeastern point of the mountain and on Depot Ø. From the latter locality KOCH (1929) described the Permian Depot Island Formation. SÄVE-SÖDERBERGH (1937) made more detailed investigations there. From the stratigraphy of the Permian beds in the western part of Canning Land it must be concluded that the dolomites which are found in the east side of the island cannot represent the same horizon as those of Kollenbjærg, but must correspond to the upper part of the shales with dolomitic beds occurring on Wegener Halvø. The conglomerates and sandstones resting upon the dolomites and called the Depot Island Formation seem to correspond to the base of the Eotrias in the sections of NOE-NYGAARD from Wegener Halvø. However, on the basis of their contents of fossils on Depot Ø they were found to be Permian and, as assumed by MAYNC (1942), may belong to the youngest Permian. Hence in NOE-NYGAARD's sections the beds indicated as lowermost Eotrias should probably be regarded as Permian. From the descriptions of sections from Depot Ø it appears, however, that the uppermost Permian already belongs to a new sedimentation cycle, which has its continuation in the marine lower Triassic (cf. STAUBER 1942). The dolomites in the spit of land off the northeastern corner of Nordenskjöld Bjærg are very probably also situated very high in the Permian series. In the coast section there, black shales succeeded by conglomerates and sandstones can be seen on top of the limestones to the west. However, I was only able to observe this locality during a rapid passage. As the position of the beds seems to have been disturbed by minor faults, a more detailed investigation should be made if the stratigraphic position of the exposure is to be definitely cleared up. I am convinced, however, that here, also, the transition from the Zechstein to the marine Eotrias may be ascertained through the late Permian Depot Island Formation.

If the question as to the boundary between the Permian and the Eotriassic series is to be cleared up, the fossil contents, the thicknesses, and the cycles of sedimentation of the sections on Wegener Halvø should be carefully investigated and comparisons made with the localities that have hitherto been described in detail.

d. The Permian Transgression.

The superposition of the Permian series on Canning Land can only be traced for some few kilometres in a west-east direction. From the depression of Ituidlek the Permian table rises about 10° towards the east and cuts across the Carboniferous beds, which dip more steeply towards the west, as far as Kollenbjærg, when it extends across the even

more steeply inclined Middle Devonian beds. The easternmost Permian locality is the aforementioned limestone cliff on the western crest of Hesteskofjæld. However, the Permian beds no doubt extended still farther eastward across the older formations. The clastic material of the basal conglomerate shows that also the volcanic Kap Fletcher Series, the Eleonore Bay Formation, and even the Caledonian crystalline rocks were exposed in the east. The thick late- and post-Caledonian molasse formations from the Devonian and Carboniferous times which covered the Caledonian substratum, were again removed by erosion in the eastern part of Canning Land in Permian times. The unconformity with the Carboniferous sandstones shows that before the deposition of the Permian series a tilting towards the west has taken place which resulted in an inclination of the Carboniferous beds of 25—30°.

In a section throughout the length of Wegener Halvø the base of the Permian series can be traced along a distance of nearly 18 kilometres. To the west, near Pingeldal, it rests on Upper Devonian sandstones. However, it has not yet been definitely ascertained whether the continental Carboniferous does not form part of this substratum. In the east, towards Ravnefjæld, the Permian extends without any variation in level across a pre-Permian fault, beyond which it rests upon folded Middle Devonian beds as far as the eastern edge of Ravnefjæld. A fault striking north-south cuts off the Devonian and Permian beds. In the eastern down-faulted part the Permian beds rise gradually from sea-level towards the region around Calamites Dal. Curiously enough, however, continental Carboniferous sandstones dipping towards the west, but not folded Middle Devonian beds, appear under the Permian beds in the lowered block. Near Calamitesdal Permian and Carboniferous beds border on Middle Devonian rocks along a fault. In the eastern elevated part of the Kap Brown area these beds are not covered by Permian deposits.

The fact that on the two sides of the fault line at Ravnefjæld the substratum of the Permian beds is formed by different formations, notably that a younger formation occurs to the east, seems at a first glance incomprehensible. The fault, as it can be observed at the present day, must be post-Triassic; for the high-lying Permian of Ravnefjæld and the deeper-lying Permian in Paradigma Bjærg originally lay on the same level. We do not know whether the Middle Devonian beds continue in the substratum of the Permian beds along a short distance east of the fault. It is, however, a fact that in the down-faulted block there must exist a tectonic boundary line between the Devonian and the Carboniferous series. However, the fault-escarpment was again peneplained before the Permian transgression and was covered by the Zechstein sea. It is hardly probable that the post-Triassic fault followed exactly the track of the pre-Middle Permian one. More detailed investigations in the region

around Tvekegledal in Fleming Fjord, may perhaps provide information about the course of the old fault.

Towards the interior of Jameson Land the Permian beds disappear beneath the Triassic sediments, but farther to the west, towards the Caledonian series of Stauning Alper, they rise again from the depression of Jameson Land. STAUBER (1940, 1942) has described this very clearly. Here, towards the large fault, the Permian beds rest everywhere on the conglomerates and sandstones of the continental Carboniferous series. Whether a distinct unconformity between the two formations also exists along this line, cannot be decided on the basis of the descriptions available so far.

Between the Caledonian rocks to the west and the western margin of the present distribution of the Permian series the large fault line extends along a belt of Carboniferous sandstones which is almost uninterrupted from Hall Fjord in Scoresby Sund to Godthaab Golf in the north. Along this line Carboniferous rocks form the substratum of the Permian deposits except on Gauss Halvø. Here, from Margrethedal to Gästisdal, the Permian beds rest on a Devonian substratum. It is this place which I termed a transverse ridge in the long Carboniferous depression. I agree with the view held by STAUBER (1942), MAYNC (1939b), and VISCHER (1943) that south of Moskusokse Fjord the Permian coast line was in the main determined by the post-Devonian main fault and its southern continuation, viz. the fault along Stauning Alper. The greater part of the Permian shore deposits along this line has later disappeared as a result of erosion, however, some few localities in which they have been preserved are described by MAYNC (Kap Franklin) and STAUBER (Karstryggen in Scoresby Land).

6. The Triassic Series.

No Triassic sediments are preserved on Canning Land. However, in the western part of the peninsula, in the impressive perpendicular wall of Nordenskjöld Bjærg about 600 metres high, they appear in the landscape, marking the eastern margin of the Jameson Land table. The slope of Liverpool Land dipping towards the west corresponds to the exposed Triassic transgression surface, as already pointed out by KOCH (1929) and ROSENKRANTZ (1929, 1934). Along the foot of this slope extends, almost in a straight line, a steep "Glintwand" (wold) (cf. Süss, Das Antlitz der Erde, Bd. II, p. 81). It can be traced along a distance of about 130 kilometres from Kap Stewart in Scoresby Sund to Nordenskjöld Fjæld in Nathorst Fjord. The steep cliff is made up of beds belonging to the Trias and the Lower Jura. In front of the "glint" ex-

tends a broad depression, which is occupied by the inner part of Carlsberg Fjord, Hurry Fjord, and the shallow broad Klitdal. The straight-lined scarp follows the elevated part of the block, viz. Liverpool Land. Where this dips down below sea-level, it likewise disappears. To the south, at Kap Stewart, the cliff descends below sea-level, and its continuation in this direction is unknown. To the north, however, it can be followed for some distance in the northern frame of Liverpool Land. The straight Glintwand terminates in Nordenskjöld Bjærg in Nathorst Fjord. Farther westward it is replaced by another, lower steep cliff, cutting into the Triassic beds. It rises towards the north and forms a curve, open to the east, across the western part of Wegener Halvø, then it descends towards Fleming Fjord, and on the north side of this fjord continues eastward as far as Kap Biot. (cf. STAUBER 1942, pls. 1 and 4). Once the steep cliff extended farther into the area of the present Davy Sund. Fleming Fjord occupies the glint furrow. East of Kap Biot the Triassic beds descend below sea-level. In the area of Davy Sund the glint furrow broadened and the abrupt cliff was displaced northward by erosion and tectonic disturbances to the area around Kap Simpson.

From Kap Stewart in Scoresby Sund the beds exposed in the steep cliff rise slowly towards the north. To the south they consist of Rhætic and Liassic rocks, in the middle of Triassic and Rhætic, and to the north, in Nordenskjöld Bjærg, of Permian and Triassic rocks. The rise of the beds attains its maximum on Wegener Halvø, whence the beds descend rapidly towards Fleming Fjord.

The elevated edge of the Jameson Land block which crops out in Liverpool Land terminates north of Canning Land. This interruption is due to a fault extending obliquely to the edge of the block, which fault must pass somewhere at the bottom of Davy Sund and Kong Oscars Fjord. In the vicinity of this supposed large fault occurs the volcanic Kap Simpson complex (cf. SCHAUB 1942) and the area of eruptives west of Antarctics Havn and Mästers Vik. Both these probably arose in connection with the faulting activity.

The structural and sedimentary conditions of the Triassic series have been dealt with at length by STAUBER (1942). I shall therefore only briefly mention some points which may complete the picture I have attempted to give of Canning Land.

West of Canning Land Permian and Triassic beds rest fairly conformably on each other, at any rate no great angular unconformity is found between them. In Nordenskjöld Bjærg the boundary zone itself is covered by talus slopes. On Depot Ø the upper limestones of the Permian series are almost conformably overlain by sandstones and conglomerates of a new sedimentation cycle. It begins with the uppermost Permian

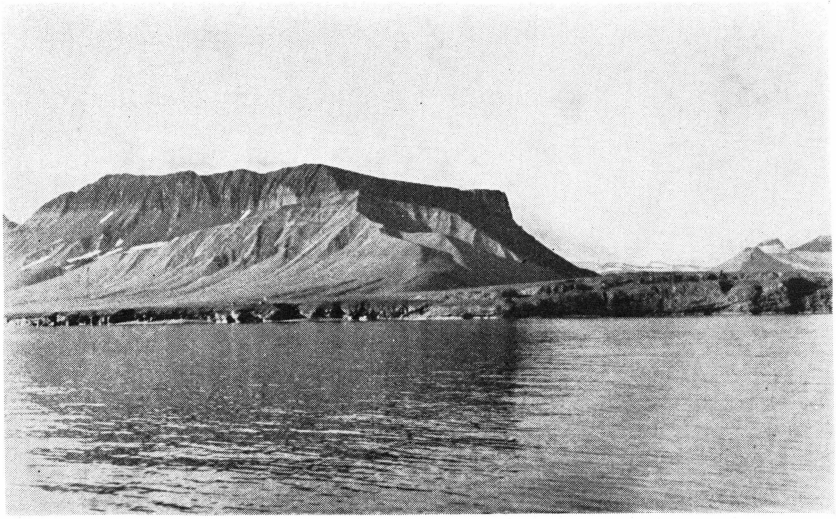


Fig. 18. Nordenskjöld Bjærg, seen from the northeast.
Along the shore beds of the uppermost Permian, overlain, in the mountain wall, by various Triassic formations. (Cf. STAUBER 1942, p. 230).

and continues with the lower marine Trias of STAUBER (1942). In Nordenskjöld Bjærg all the three Triassic series distinguished by STAUBER are represented: At the base the marine Eotriassic series, which is here covered by débris; its thickness was estimated by STAUBER to be 120—150 metres. It is succeeded, in the middle part of the mountain, by coarse arkoses and conglomerates of a thickness of about 240 metres, which are referred to the continental series, and at the top by the intensely red multicoloured series of a thickness of about 300 metres.

In the region around Klitdal south of Carlsberg Fjord the marine Trias is lacking, the middle horizon, the continental series, at the western foot of Liverpool Land resting directly upon the Caledonian crystalline rocks. To the north, however, on Wegener Halvø, marine Triassic beds are present. They rest more or less conformably on the Permian deposits.

In contrast to the Permian shallow water deposits, the Triassic beds on Jameson Land are sediments which have been deposited in a depression. After an interruption during Permian times, they continued the old sedimentation style commenced in Devonian times. As regards the Triassic deposits it is possible, by the aid of the extensive exposures, to reconstruct the boundary and depth of the depression. STAUBER (1942) has done this on the basis of the varying thickness and the facies sequences and has given a detailed description of the development of the Jameson Land basin in Triassic times.

Below the Triassic sediments, the sandstones, arkoses, and conglomerates dominate again, interbedded with a rhytmic alternation of deposits from a quiet time, sandy shales and gipsum. This sedimentation reflects the events which took place in the areas of erosion, upheaval and denudation along the edges of the blocks and subsidences and accumulations in the interior of the basins. According to STAUBER (1942) and BIERTHER (1941) the maximum thickness of the Triassic series amounts to about 1600—1700 metres, a thickness which according to its order of magnitude agrees with the Carboniferous fillings of the depressions, the orogenic series in the Devonian trough (BÜTLER 1935 b), and the later accumulations in Jurassic times (cf. BIERTHER 1941).

V. THE FAULTS

1. General Remarks.

The detailed investigations which have been made on the expeditions to East Greenland under the leadership of Dr. LAUGE KOCH have shown that the eastern marginal zone of the Greenland land mass between Scoresby Sund and Grandjean Fjord has been lowered in proportion to the inner fjord zone and has been split up into blocks. The fault called by VISCHER the post-Devonian main fault and its southern continuation, the large fault in Stauning Alper, have repeatedly been referred to. This large fault line has evidently arisen from several faults which succeeded each other and extend more or less parallel to the outer coast. Considering the course of the coast-line we may accordingly call them longitudinal faults. North of Franz Joseph Fjord they intersect the Caledonian and Devonian structures at acute angles or are nearly parallel to them.

From Sofia Sund, however, this large fault intersects, towards the south-southwest, the Devonian area as far as Kong Oscars Fjord (cf. pl. 3). Onward, from Syltoppene in northeastern Scoresby Land, it cuts obliquely through Caledonian structural elements of the western zone. The course of this fault zone is known as far as the interior of the Scoresby Sund region, while its southward continuation through Knud Rasmussens Land has not yet been ascertained. It must be assumed that it continues obliquely across the whole Caledonian folding zone in a southwesterly direction as far as and even beyond the western margin of the mountain range. South of Scoresby Sund the whole Caledonian zone east of the fault may have been lowered and overlain by thick younger basalt sills and accordingly escapes observation.

The amount of displacement between the high-lying western and the down-faulted eastern block may be estimated to vary from two to five or six kilometres. In various places the fault is resolved into steps moving away from each other, thus for instance on Gauss Halvø, the eastern part of Ymer Ø, and Traill Ø. The faults are not equally distinct in the landscape everywhere, and the movements along them do not seem to have taken place at the same time everywhere.

The different degrees of down-throw in the longitudinal direction of the fault must have some connection with the transverse faults, which divide the lowered coast stretches into a mosaic of blocks. Longitudinal faults of the second or third order which run more or less parallel with the main fault intersect these blocks. In spite of their in part very considerable throw they can often only be traced along short distances. The large blocks are intersected into block fields, the individual parts of which are ununiformly dislocated.

2. The Faults on Canning Land and Wegener Halvø.

In spite of the often considerable amount of displacement, the faults that can be observed on Canning Land and Wegener Halvø are dislocations of the second or third order. They occur in the northern part of the elevated edge of the large northwestward dipping block of Jameson Land. As far as can be seen from STAUBER's (1942) and KRANCK's (1935) maps, they continue neither northward nor very far southward.

Mention has already been made of the fault which at Kap Brown, the easternmost point of Wegener Halvø, marks the present eastern limit of the Devonian rocks. The Devonian deposits with the underlying volcanic Kap Fletcher porphyries have been thrust down against the quartzites of the Eleonore Bay Formation, which occupy the coast stretches around Kap Brown. The throw of the fault cannot be definitely stated, but may be estimated at more than 1000 metres. Towards the south I connect this line of disturbance with the faults which separate the Old Red of Canning Land and the effusive rocks of the Kap Fletcher Series from the pre-Cambrian rocks to the east. Here, also, the western block has been lowered. South of Aalborg Fjord the fault has developed into a step-fault, since a fracture line branches off towards the southeast, cutting across the Kap Fletcher peninsula, while the other extends in a southerly direction to Carlsberg Fjord. The eastern step-fault, possibly of a height of about 800 metres, now separates the volcanic Kap Fletcher rocks from the limestones of the Eleonore Bay Formation in the northeast. The down-thrust along the western fault-cliff may amount to further 500—600 metres; here Middle Devonian beds to the west meet with the volcanic series to the east along the fault plane. On air photographs the gneisses of northern Liverpool Land can be seen to be cut across by lines of disturbance. They may be assumed to be the southern continuations of the faults on Canning Land.

The age of this fault along the eastern margin of the Devonian deposits cannot be more accurately determined owing to the lack of younger beds. On Canning Land the fault tracks gave rise to the devel-

opment of valleys extending in the direction north-south, however, in the upper levels of the present topographical surfaces of the blocks no essential difference can be observed on either side of the fault. As compared with other fault-cliffs within this region which can be more accurately determined, this fault warrants the conclusion that it must be of comparatively ancient origin. Since the altitudes of the summits on Canning Land on both sides of the fault are for some distance on the same level as an old land surface, I would regard its age as pre-Permian.

In Calamitesdal another, approximately north-south directed fault cuts across Wegener Halvø about four kilometres west of the above-mentioned fault (cf. NOE-NYGAARD 1934, SÄVE-SÖDERBERGH 1937). Along this, the western limb has been lowered. Continental Carboniferous, Permian, and Triassic are here adjacent to Middle Devonian beds. The subsidence may here amount to 500—600 metres. The fault is fairly distinct morphologically, the highest points of the two blocks differing greatly. The displacement must have taken place in post-Triassic times. No southward continuation of the fault into Canning Land could be ascertained. Accordingly there the beds dip much more strongly towards the west than near Calamitesdal.

The fault which crosses Wegener Halvø near Ravnefjæld appears very distinctly in the landscape. At the foot of the steep cliff which forms the eastern termination of Ravnefjæld, the Permian and Triassic beds exhibit a flexure-like lowering. The fault extends almost in a straight line in a north-south direction from Tvekegledal to the eastern foot of Quensel Bjærg, continuing through the Triassic area of northern Jameson Land to the neighbourhood of Passagedal. Here the fault dies out, and the Triassic series on either side of it are of about equal height. From Passagedal the Triassic beds west of the fault rise rather rapidly northward, the height of their base culminates with c. 800 metres above sea-level in Ravnefjæld in the western part of Wegener Halvø (cf. STAUBER 1942, pl. 6), whence they descend rapidly towards Fleming Fjord, where they disappear below the level of the sea. Thus a broad anticline is reflected in the Triassic beds, the axis of which almost coincides with the longitudinal direction of Wegener Halvø and rises towards the north-east. In this broad warping an oblique north-south directed transverse zone between Ravnefjæld and Calamitesdal has been down-faulted so as to form a trough. The down-faulted block it cut up by several minor faults into antithetic steps; the faults appear in the Permian limestones in Nathorst Fjord as small fault cliffs, while in Fleming Fjord, on the north side of the peninsula, they give rise to flat fold-like structures. The trough-fault is limited to the upwarped area of the Triassic and Permian beds between Nathorst Fjord and Fleming Fjord.

The age of this fault may, no doubt, be regarded as post-Triassic. Its remarkable prominence in the landscape suggests that it is a Cretaceous or Tertiary fault. It has already been stated (p. 71) that an ancient pre-Permian—post-Carboniferous fault may occur immediately east of Ravnefjæld. To the west the Permian beds rest upon folded Middle Devonian, to the east on continental Carboniferous rocks, however, this change in the position of the two ancient series cannot be accounted for. At the time of the Middle Permian transgression the fault-cliff had already been peneplained. So far nothing definite can be said about the course of this old fault. From some indications it may be assumed that it strikes towards the northwest and is cut across in the northeastern part of Ravnefjæld by the post-Triassic fault.

In the mention of the Upper Devonian series on Wegener Halvø reference was made to a pre-Permian fault which in the western part of Ravnefjæld separates the Upper Devonian from the Middle Devonian beds. In this place the western part has been lowered, so probably it was through this old faulting activity that the Middle Devonian beds in Ravnefjæld were elevated as a horst.

In the eastern part of Canning Land a large fault must be found between the low hills along the shore near Kap Tyrrell and the Kap Tyrrell Bjærg, 700 metres high. From the construction of the sections it appears that the beds of the Eleonore Bay Formation in the proximity of the cape lie 600—700 metres deeper than the corresponding beds in the anticlinal limb of the mountain. The course of the fault line could unfortunately not be traced in the terrain, but probably it extends towards the south in the broad glacier-filled cirque valley east of Bowensbjærg. The axial rise of the Caledonian anticline towards the east is partially compensated by this antithetic fault.

Thus, some north-south directed faults have been ascertained in the area of Wegener Halvø and Canning Land. Some of them appear distinctly in the landscape, namely the young, probably late-Cretaceous or early Tertiary faults. They extend only over short distances. The other faults cannot be ascertained from the present level of the surfaces of the blocks, they are partially covered by a continuous table of Permian rocks. Probably they are of late Carboniferous or Lower Permian age. Old and young faults are disposed as longitudinal faults in the northern portion of the elevated eastern margin of the large block of Jameson Land.

3. The Transverse Faults.

As already stated at the beginning of this chapter, large differences in the amount of dislocation can be ascertained along the post-Devonian main fault. The differences are still greater along the eastern margin

of the antithetically arranged blocks, where the elevation is very unequal. Hence transverse faults must be present, which in places exhibit large throws. Between Gauss Halvø and Scoresby Sund these transverse disturbances are not very conspicuous, chiefly because the outer margins of the blocks are hardly distinguishable in the depression zone and because the transverse faults lie partially in the fjords so that the fractures through the displaced rock series are not visible. However, from the difference of the two shores of the fjord we may conclude that greater stratigraphical disturbances exist. Thus, for instance, a zone of large transverse disturbances must extend across Davy Sund, the southern entrance of Kong Oscars Fjord. While on Canning Land Caledonian crystalline rocks are found at Kap Wardlaw, and lower Eleonore Bay Formation and Middle Devonian rocks at Kap Brown, Upper Jurassic and Cretaceous sediments in addition to young eruptives are met with at Kap Simpson on Traill Ø, according to the maps of SCHAUB (1942) and STAUBER (1942). Along a horizontal distance of about 35 kilometres a subsidence of stratigraphic series has taken place the total thickness of which, if completely preserved, may be estimated at about 10,000 metres. How this lowering, especially of the pre-Cambrian and Palæozoic series, took place, it is impossible to say. The different structural characters of the Kap Biot and the Kap Simpson districts, however, warrant the conclusion that it cannot be a simple inclination of the series of strata. The altitudinal map of the Triassic substratum by STAUBER (1942, pl. 6) now gives us some clues as to the altitudes of the Triassic basal beds within the different areas. If, according to this map, we imagine a continuation of the altitudinal contours of the Triassic base, on the basis of the old Triassic transgression surface across Canning Land and Wegener Halvø and a prolongation of them along a line running through Davy Sund-Kong Oscars Fjord, we shall arrive at a difference in the altitude of the Triassic basal beds on the sides of this line of more than 2000 metres. As far as the Triassic base is concerned, the northern area lies c. 2000 m. lower than the southern area. If we follow STAUBER's map towards the northwest into Kong Oscars Fjord, the differences in level between the two sides of the fjord decrease, and subsequently the proportion is reversed, the base of the Triassic series on the Traill Ø side being more elevated than in Scoresby Land on the opposite side of the fjord. It must be assumed that a fault line passes through Davy Sund and the outer part of Kong Oscars Fjord, along which line considerable dislocations have taken place in post-Jurassic times. Although these are not indicated in STAUBER's map, the existence of a rotatory fault may be assumed. As regards the older rock series, the Devonian and the Carboniferous, whose presence in the deeper parts of the Kap Simpson area may be supposed, the altitudinal difference

between the northern and the southern area would amount to much more than for the Triassic series. The same also applies to the Caledonian basement. It may be assumed that movements took place here already in pre-Triassic times: Uplifts in the southern area and subsidence of the northern limb within the area occupied by the present outer coast.

The position of the different parts of the blocks in relation to each other can, of course, also be seen from the geological maps. The Caledonian substratum of the sedimentary series occurring on Liverpool Land and Canning Land, descends below sea-level near Davy Sund, to appear at the surface again in the north only on Gauss Halvø, and at the outer coast only near Gael Hamkes Bugt (VISCHER 1943).

It has already been mentioned that the young eruptive masses in the Kap Simpson area and in northeastern Scoresby Land may have some connection with the displacements along the transverse fault in Davy Sund. It is possible that the difference in level on the two sides of the fault-line may also have influenced the direction of movement of the sliding nappe (Gleitdecken) observed by STAUBER within the Triassic series (1940, 1942).

VI. AN ATTEMPT TO RECONSTRUCT THE EARLIER STRUCTURAL CONDITIONS OF THE SERIES OF BEDS ON CANNING LAND

1. General Remarks.

The post-Caledonian sediments which occupy the western part of Canning Land exhibit a very clear and simple geological structure. It may be assumed that the beds were originally deposited in an approximately horizontal position and that they have afterwards been tilted on various occasions. Since from this part of the area a large number of measurements of the beds are at my disposal, I have attempted to obtain structural pictures of the different periods of time by restoring to a horizontal position first the youngest and then the older beds.

Within the vast Devonian area there exist, it is true, numerous variations in the strike and dip of the beds, still they are grouped around an ascertainable average value, which has been used in the constructions. However, this also means that the reconstructions may only give a rough picture of the general structural features.

In the construction of the angles between the bedding planes and of the tilting and the rotations of the planes the Wulff net was used (cf. WEGMANN 1929). The mean values for the position of the beds were inserted with their poles on a sheet of transparent paper which could be rotated around the centre of the net. Then the Permian, the youngest deposits represented within the area, was placed in a horizontal position, the pole of the face of the sheet being, by means of rotation, placed on the great circle of the equator or of the central meridian and then, corresponding to the angle of the dipping, moved back to the centre of the net. In this position of the sheet the other poles of the face were shifted on their small circles in the same direction and at the same angles, after which the sheet was rotated back to its original position and the new position of the poles of the face, respectively the strike and dip of the beds, were noted down. From the position of the limestones in the two limbs of the Caledonian anticline the axial direction of the fold was approximately determined by means

of the net and was inserted as a pole of a face. The mean values of the poles of the fault planes, like those of the beds of rock, were inserted in the diagram. The values obtained through the construction, together with the geological symbols, were then transferred to a small map, one for each period. In order to facilitate the localisation of the symbols of the starting points the outlines of Canning Land have been retained also in the presentation of the structural conditions of earlier times (cf. fig. 19).

Various objections may, of course, be raised against the use of the points of the stereographic representation obtained. In the first place the measurements, especially in the Caledonian area, are limited to some few localities, furthermore, owing to local stratigraphic disturbances which could not always be fully elucidated, there were great deviations from the measured values which are regarded as normal in the mapping. Thus the reconstruction of the eastern area must be limited to a few main points, viz. the position of the two limbs of the fold and the axial direction of the anticline determined by them. The thrust-plane in the core of the fold is cut across by transverse faults and the fragments displaced in relation to each other. The connection of the individual fragments observed is doubtful, and the representation of this thrust-plane was therefore omitted in the construction.

Furthermore, the presence of faults will always limit the use of this reconstruction on a comparatively small area. It is true that along the faults the series of strata are often displaced parallel to each other, dragging on the fault-plane disregarded, but often they also function as hinges and in such cases the angle of rotation may be measured. However, this is only possible when such series of beds on either side of the fault can be compared with each other as had the same position before the displacement. This can only be done along some of the faults. The faults accordingly occasion great inaccuracies in the constructions. The reason why I make this attempt in spite of these deficiencies is that it may induce other workers to use such reconstructions in areas of East Greenland which have been more thoroughly investigated and whence a greater number of measurements and detailed field investigations are at hand.

2. Results of the Reconstructions.

The small map of the post-Permian time and the diagrams (figs. 16, 17, 19) indicate the present structural conditions, the map for the whole area of Canning Land, the diagrams only for the region around Kollenbjærg.

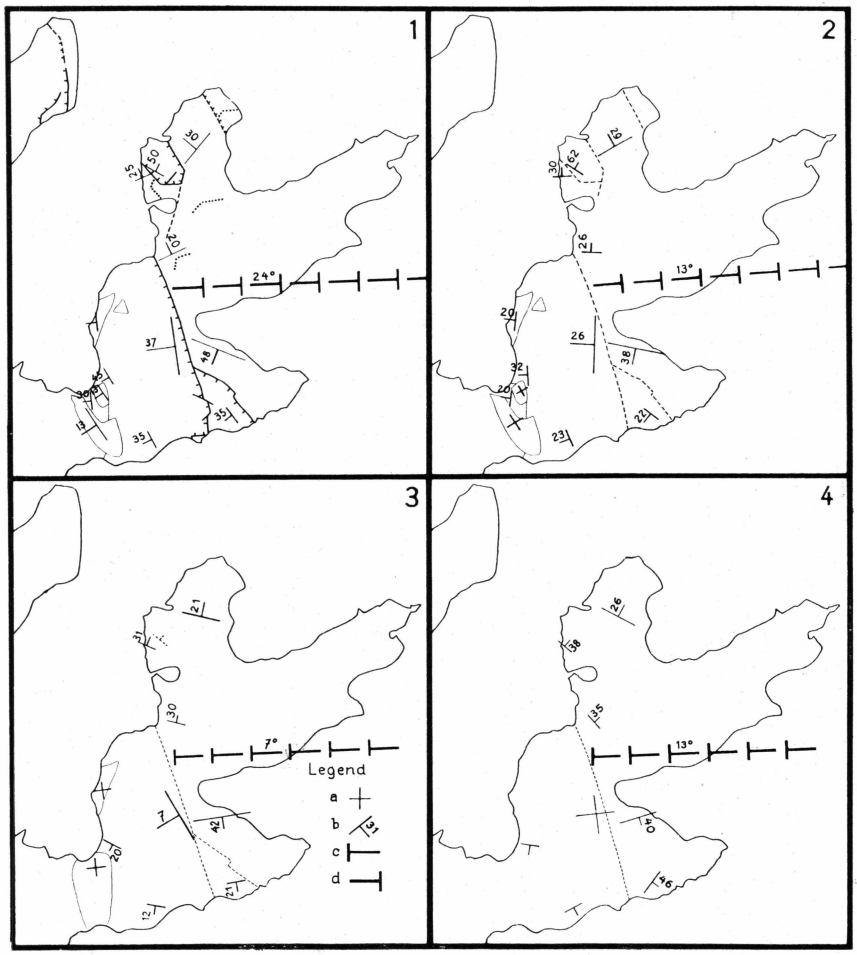


Fig. 19. Reconstruction of the position of the beds on Canning Land during different geological periods.

Map 1. Structural map showing the present conditions.
— 2. Structural map showing the conditions during the deposition of the Permian beds.
— 3. Structural map showing the conditions during the deposition of the continental Carboniferous series.
— 4. Structural map showing the conditions during the upper Middle Devonian period.

a) Horizontal position of the beds.
(in 2 the Permian, in 3 the Carboniferous, in 4 the Middle Devonian).
b) Strike and dip of the beds.
c) The Caledonian folding axis, axial inclination towards the east.
d) The Caledonian folding axis, axial inclination towards the west. The figures indicate the approximate amounts of the axial inclination in degrees.

For the boundaries of the geological formations the reader is referred to the geological map in pl. 4.

On the map of the Permian period the Permian beds, which on an average dip 13° towards the N. 123° W., have a horizontal position; the positions of the other beds have been altered in accordance with this. The faults, which run more or less parallel with the strike of the Permian beds, retain their direction almost unaltered, whereas their angle of inclination is changed.

At the present day the Carboniferous beds dip on an average 30° towards the N., 96° W.; if we use the map of the Permian as a basis, it must be elevated 20° in the direction north, 80° west in order to become horizontal. In this way the Devonian beds obtain a rather horizontal position, and the strike of the Caledonian beds is much changed. The fault lines, especially in Porfyrfjæld, obtain positions which are impossible, and accordingly we must assume a post-Carboniferous age for these disturbances. They probably came into existence simultaneously with the strong pre-middle Permian tilting of the Carboniferous beds on Canning Land.

For the Middle Devonian series an average gradient of 37° N. 98° W. was computed. In the region around Kollenbjærg, however, the divergence from the Carboniferous beds is much greater, since here it dips 40—45° N. 110—120° W. If the Carboniferous beds are horizontal, the Middle Devonian beds will show an average inclination towards the west of 7°. If this small angle is eliminated, it will result in an appreciable change of the direction of the strike of the pre-Cambrian limestones around Kap Tyrrell and Kap Fletcher. On the other hand, the direction of the axis of the Caledonian anticline has remained fairly constant during all the changes, although, according to the direction, it is almost perpendicular to the direction of the strike of the westward-dipping plateau sediments. In the movements of the series of strata it only gives rise to a tilting in the longitudinal direction, and at the end of the construction the axis of the fold descends towards the east, that is, a fold which to-day rises towards the east becomes, for the pre-Devonian period, an axis pitching towards the east. This was, of course, to be expected from the outset if it is assumed that Liverpool Land is the elevated edge of the tilted Jameson Land block. The computed or constructed angle of tilting of 37° may, at any rate, be somewhat too high, since between the western region used in the computations and the Caledonian eastern area the fault passes along the Devonian boundary, which boundary must to some extent have acted as a hinge. However, the order of magnitude of the angle of tilting suggests that the ancient transgression surfaces which cut across the Caledonian and Devonian beds cannot possibly show the same inclination farther westward. From the highly inclined Carboniferous beds we must assume that pre-Triassic faults, which as a whole form an antithetic structure, are present beneath

the undisturbed Triassic sediments in the Jameson Land basin. STAUBER (1942, pl. 5) indicates this in his sections.

For the volcanic Kap Fletcher Series the construction could unfortunately not be carried through. At the base of this series there occur, indeed, well bedded breccias which were originally horizontal. However, the superposition of these beds on the Eleonore Bay Formation could only be measured in one place on the Kap Fletcher peninsula. An angular unconformity of about 26° could be ascertained between the two series of strata. However, the point of observation is situated between two step-faults, and it would be too bold to prepare a construction for the whole Caledonian Canning Land area on the basis of this single highly disturbed locality. But it is beyond doubt that from a construction based on more reliable measurements of the Kap Fletcher Series information might be obtained about further changes in the position of the Eleonore Bay Formation in pre-Devonian times.

From the present examples of construction, but especially from the comparison of the structural elements of Canning Land with those of Wegener Halvø, the conclusion must be drawn that the great movement had different effects on the individual parts of the blocks, and that, at any rate in the region towards Davy Sund, at the northern end of the elevated eastern margin of the large unit termed the Jameson Land block, the displacements may be characterised as differential movements within smaller blocks.

VII. SUMMARY

1. The Object of the Investigation.

The object of the present paper is to supplement the previous knowledge of the geological structures of the rock series found on Canning Land on the basis of observations made in the field and to give a diagrammatic representation of them by the aid of papers already published by other authors.

2. Geologic-Tectonic Survey of the Coastal Area.

On the basis of the geological literature and the author's own observations a survey is taken of the structural divisions of the area north of Scoresby Sund.

The crystalline areas are divided into:

a) An inner zone, the elevated Caledonian area, in which the crystalline rocks occupy an intermediate belt between two sedimentary zones.

b) An intermediate zone in Hudson Land and Payer Land, in which crystalline massifs of the Caledonian basement were elevated through thrusting activity in Devonian times and driven towards the west. In the northern area of the Devonian sandstones their relations to these rocks have remained unaltered.

c) The crystalline zones east of the post-Devonian main fault. They are likewise derived from the Caledonian basement-rock and have to some extent been included in the Devonian dislocations. Along the elevated edges of the tilted blocks the crystalline rocks have been denuded by erosion (cf. VISCHER 1943). The crystalline series on Liverpool Land forms one of these elevated block margins.

Between Liverpool Land and Giesecke Bjærge north of Franz Josephs Fjord the substratum of the post-Caledonian covering sediments is nowhere exposed. In this part of the coast there is an ancient geological

depression which is traceable westward in the middle and northern regions across the post-Devonian main fault and right into the area of the folded Eleonore Bay Formation. It is due to this axial depression in the Caledonian folds that the younger Caledonian series and parts of the Old Red molasses have been preserved.

In the area of the southern part of Traill Ø and northern Scoresby Land the Devonian beds were much lowered by faulting, only cropping out again on Wegener Halvø and Canning Land with the rising Caledonian bed-rock. Canning Land and Wegener Halvø are situated in the transitional zone between the down-faulted part of the block which forms the Jameson Land basin and the elevated eastern margin of this, which rises as a crystalline ridge in Liverpool Land. This transitional zone lies approximately on the axial lines along which the various tilting movements of the large block took place. Several faults intersect the area more or less parallel to these axes of rotation, so that it is subdivided into narrow block-compartments.

3. The Rock Series on Canning Land.

a. The Pre-Cambrian Series.

In the central and eastern parts of Canning Land a portion of a Caledonian anticline is preserved. Its core consists of the dark shales of the pre-Cambrian Eleonore Bay Formation. In its deepest parts a light-coloured late Caledonian granite, intruded into the shales, is exposed at Kap Wardlaw. In the limbs of the anticline remnants of the middle Eleonore Bay Formation, the so-called multicoloured series, are preserved, and on the Kap Fletcher peninsula the basal beds of the upper limestone-dolomite series are still present.

The axis of the anticline strikes approximately in the direction west-east, rising towards the east. The core of the fold is thrust up on the northern limb of the fold, while the reversed middle limb is highly pinched out and broken off (pli-faille). The direction of the clean-cut forms an acute angle with the axis of the fold: the upthrust possibly took place during a somewhat later stage of the compression.

The direction of this Caledonian fold on Canning Land seems to coincide with that of the large fold found in the middle part of Liverpool Land. But it forms almost a right angle with the direction of the Caledonian folding, which can be traced northward from the northern part of Scoresby Land. How these different folding directions are connected with each other, cannot yet be made out.

b. The Volcanic Kap Fletcher Series.

The highly eroded Caledonian fold on Canning Land is unconformably overlain by a series of predominantly volcanic rocks. The Kap Fletcher peninsula has been chosen as a type locality, and the series is called the volcanic Kap Fletcher Series. This sequence of strata is succeeded by the upper Middle Devonian sandstones.

At the base of this volcanic series there occur breccias, arkoses, and tuffitic sandstones, the material of which is of clastic as well as of volcanic origin. Then follow beds of porphyritic extrusive rocks and tuffs. The rocks of this series, at present found *in situ* on Canning Land, have been lowered through ancient faulting activity and have thus escaped erosion.

The bedded deposits of terrigenous as well as of volcanic origin suggest that they were laid down in a landscape of basins. The strong erosion of the Caledonian rocks and the volcanic activity that set in at the same time are probably indications of tectonic phenomena in this region. The time for this activity cannot be difinitely determined. The volcanic structures were eroded to a large extent before the deposition of the thick upper Middle Devonian sandstone series, however, at the time of this deposition large areas in which the volcanic formations formed a continuous covering of the Caledonian substratum still existed. The Old Red series covered a somewhat peneplained volcanic landscape intersected by ravines. The volcanic Kap Fletcher Series marks the beginning of the Devonian deposition in this region. Whether it set in already in Lower Devonian or in lower Middle Devonian times, cannot be definitely decided. The area of deposition of the volcanic formations was located in the interior of the developing Devonian trough. Through the later elevation of the margin of a fault-block part of the bottom of the trough with the oldest deposits filling it became visible.

c. The upper Middle Devonian Series.

On top of the volcanic Kap Fletcher Series, but separated from it by a hiatus, lie the sandstones of the upper Middle Old Red series. On Canning Land they are preserved to a thickness of at least 3000 metres. Their age was determined by SÄVE-SÖDERBERGH (1937, 1938) on the basis of fish remains.

The great thickness of the deposits suggests a considerable subsidence of the sedimentation area and accordingly differentiations in the altitude of the various parts of the Caledonian peneplain in Middle Devonian times.

From the outcrop of immense Devonian series on Wegener Halvø and Canning Land the conclusion may be drawn that the broad depression in which the East Greenland Old Red series was deposited extended southward into the area of Scoresby Sund. Its western boundary can be traced from Ole Rømers Land to Kap Peterséns at the northernmost point of Scoresby Land. At Syltoppene it is cut across by the post-Devonian fault in Stauning Alper. However, the Devonian continues southward below the younger sediments of the down-faulted block through the southern part of Traill Ø and the eastern part of Scoresby Land.

The Middle Devonian deposits in the region around Ravnefjæld on Wegener Halvø exhibit folds which must be older than the Upper Devonian within the area. They seem to be more or less parallel with the direction of the axis of the Caledonian fold on Canning Land.

d. The Upper Devonian Series on Wegener Halvø.

Southwest of Ravnefjæld a series of Devonian beds was observed which was determined with reservation as Upper Devonian by SÄVE-SÖDERBERGH (1937). It rests unconformably on Middle Devonian strata and, in Ravnefjæld, is separated from the latter by a pre-Permian fault. The conglomerates of this Upper Devonian series contain numerous pebbles derived from the Middle Devonian sandstones. However, the greater part of the deposited material is derived from the more remote elevated Caledonian regions.

The Upper Devonian series, also, has been somewhat folded. Its synclines and anticlines are transverse to the direction of the Middle Devonian folds within the area.

e. The Carboniferous Series.

In the western part of Canning Land conglomerates and sandstones of the continental Carboniferous series rest unconformably on Middle Devonian rocks. According to SÄVE-SÖDERBERGH (1937) they belong to the Dinantian. Towards the north and east they overlie deeper series of the substratum. The Carboniferous series, in its turn, is overlain unconformably by Middle Permian beds. The angular unconformity between the Devonian and the Carboniferous in Kollenbjærg amounts to about 20°, and between the Carboniferous and the Permian beds to about 30°.

Some general problems concerning the distribution of the continental Carboniferous series in East Greenland are discussed.

The western boundary of the Carboniferous series seems in the main to be determined by the large post-Devonian main fault. This faulting was initiated in Lower Carboniferous times. In its longitudinal extension it may be divided into the following sections.

1) The post-Devonian main fault between Bessels Fjord and the eastern part of Ymer Ø (cf. VISCHER 1943, fig. 23). It cuts across the older structures at rather acute angles and may be characterised as a longitudinal fault.

2) The diagonal fault, which cuts obliquely across the Devonian area southwestward from Ymer Ø as far as Kong Oscars Fjord.

3) The fault along Stauning Alper and its southern continuation. It intersects the folds of the western elevated Caledonian area at acute angles.

The western boundary of the Carboniferous deposits cuts obliquely across the area of the Devonian rocks in the southwest.

Along this main fault two depressions can be distinguished in the Carboniferous sedimentation area. Thus, a broad southern one, traceable from the Scoresby Sund region to Gauss Halvø. In this depression the deposits of the Lower Carboniferous and the Upper Carboniferous overlie each other conformably. In Dinantian times a narrow basin extended northward even beyond Moskusokse Fjord. In the eastern part of Gauss Halvø a ridge then developed in the depression, and on this ridge, along the main fault, part of the Carboniferous series was down-faulted into a narrow graben, while the other part was removed by erosion.

In the area of the northern narrow Carboniferous depression the Carboniferous beds rise with the tilted blocks towards the east and are bounded on this side by an escarpment of erosion. However, this does not probably lie very far from the original eastern boundary of the depression. In the southern depression zone, between Franz Josephs Fjord and Davy Sund, the Carboniferous beds descend eastward beneath younger sediments. How far eastward they extend here, is unknown. The Carboniferous beds which crop out on Canning Land and Wegener Halvø are derived from the interior of the Carboniferous depression.

f. The Permian Series.

On Canning Land a considerable westward tilting of the beds has taken place after the deposition of the continental Carboniferous and prior to the deposition of the Middle Permian series. In the central part of Wegener Halvø the Carboniferous beds are likewise obliquely tilted

towards the west. The tilting of the beds was in part compensated by pre-Permian antithetic faults. Strong abrasion has removed the elevated edges of the blocks and peneplained the fault-cliffs, so the Permian transgression met with a relief very rugged in the details but as a whole somewhat levelled out. Thus the Middle Permian shallow sea was able to cover the whole area westward as far as the large main fault. Where the débris resulting from the Lower Permian erosion has been carried, we do not know. The main mass of the basal conglomerate of the Permian limestones is constituted by the porphyries of the Kap Fletcher Series and various Caledonian rocks. This shows that in the eastern uplifted area the huge Devonian and Carboniferous series had already been removed during the Middle Permian period.

The reef formations, limestone beds, and shale deposits indicate a fairly quiet marine sedimentation, not interrupted by any inundation with coarse-grained material from the land. Towards the western boundary of the Zechstein sea, however, littoral formations are present: thick beds of conglomerate, shelly sandstones, deposits of gypsum laid down in lagoons, etc. Such deposits are described by BIERTHER (1941) from the surroundings of Mästers Vik in the eastern part of Scoresby Land and by STAUBER (1940) from the regions around Schuchert Elv.

In the uppermost Permian times the block-faulting movements set in again. From the basal conglomerates of the uppermost Permian Depot Island Formation and the Eotrias KOCH (1929) and NOE-NYGAARD (1937) mention quartz pebbles and a few Kap Fletcher porphyries in addition to dolomitic limestones and rolled fossils derived from the subjacent Zechstein beds. These indicate that the Permian series east of Depot Ø had been removed by erosion locally, that there the bottom of the Zechstein sea was elevated above the level of denudation, and that an erosion slope existed towards the west. With the uppermost Permian, the Depot Island Formation, a fresh local erosion and sedimentation cycle set in, which formed the transition to the sandstone deposits of the Triassic series.

g. The Triassic Series.

In contrast to the Permian shallow water deposits, sandstones and arkoses were deposited in a broad depression during Triassic times. The old style of sedimentation, as commenced in Devonian times, was continued.

Since in the region around Klitdalen, in the western part of central Liverpool Land, the middle division of the Triassic series transgressed

directly over the Caledonian substratum, it must be assumed that the southern part of Liverpool Land, which was originally more highly elevated, subsided during the Triassic period. The rising shore-lines gradually caused a change of the direction of the crystalline ridge. The Triassic and Jurassic beds, which form a cliff along the western side of the Liverpool Land ridge from Kap Stewart to Nordenskjöld Bjærg, rise slowly from the south towards the north, indicating a subsidence of the southern part.

A marked warping of the Triassic beds is traceable across Wegener Halvø, while farther northward the beds again descend to the level of the sea.

4. The Faults.

Several large faults can be ascertained on Canning Land and Wegener Halvø. On the east the Devonian series is separated by faults from the Caledonian rocks. Since no younger series are present, the age of these faults cannot be definitely settled. For various reasons this fault zone is assumed to be pre-Permian. In the middle and western parts of Wegener Halvø undoubted pre-Permian faults can be assumed to exist and observed. Post-Triassic faults, which are conspicuous in the landscape owing to the non-peneplained edges of the blocks, bound a block which has been down-faulted so as to almost form a graben, and cutting across the upwarped Triassic and Permian beds.

All these faults extend approximately in the direction north-south as faults of the second or third order of magnitude more or less parallel with the large main fault observed to the west and the supposed fault east of Liverpool Land.

It must be assumed that another important fault line, which cuts obliquely across the Jameson Land—Liverpool Land block, extends through Davy Sund and the outer part of Kong Oscars Fjord. From STAUBER's map (1942, pl. 6) the existence of a rotatory fault may be inferred. The Caledonian series of rocks, as well as such Devonian, Carboniferous, and Permian deposits as may be present, disappear deep below sea-level in the area of Davy Sund north of Canning Land. The lowering of the series of strata in this place must be due to a fault of a considerable throw. It is assumed that the volcanic formations of the Kap Simpson complex and the region around Mästers Vik are genetically connected with movements along this fault zone.

In the region of Scoresby Sund, also, the large Liverpool Land—Jameson Land block must be bounded by an important tectonic line of disturbance.

5. Reconstructions.

An attempt is made, by means of the Wulff net, to reconstruct the stereographic position of the beds in the individual geological periods. It appears from the constructions that through the tilting of the blocks the Caledonian anticline on Canning Land obtained a reversed axial gradient as compared with the original conditions. The fold, which at the present day exhibits an axial rise towards the east, originally descended in an easterly direction.

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Færdig fra Trykkeriet den 14. Februar 1948.

PLATES

Plate 1.

Map of Canning Land and the eastern part of Wegener Halvø.

The map was drawn partially on the basis of the already existing maps. It has served as a basis for the construction of the geologic maps and of the sections and stereograms (cf. pls. 2, 4, 5, and 6), which were drawn on the same scale.

The vertical distance between the stippled contour lines is approximately 200 metres. The outlines of the glaciers are dotted. The place-names have been taken from the maps by J. P. KOCH (1902), A. NOE-NYGAARD (1934), and G. SÄVE-SÖDERBERGH (1937). New names are "Aarhus Bjærg" west of Aarhus Bugt and "Aalborg Bjærg", the highest point of Hesteskofjæld at the head of Aalborg Fjord.

The place-name "Kap Tyrrel" was proposed by A. NOE-NYGAARD (Medd. om Grønl. Bd. 101, No. 1, 1934, p. 8) and indicated on his map. The name has probably reference to G. W. TYRRELL, who in 1932 (Geol. Mag. vol. 69, 1932) described some eruptive rocks from Kap Parry. In the present paper NOE-NYGAARD's spelling of the name is used on the plates, while the correct spelling is used in the text.

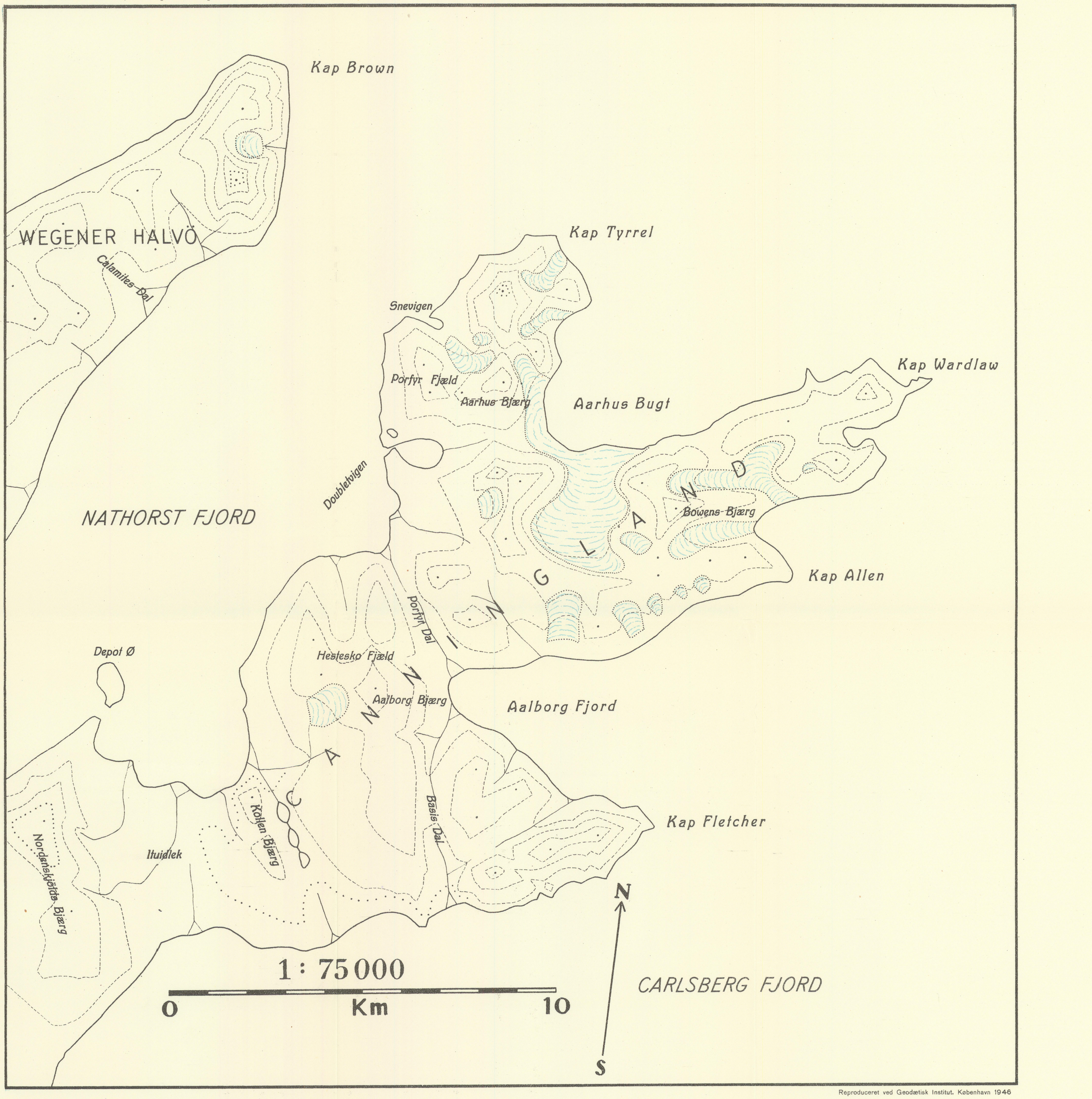
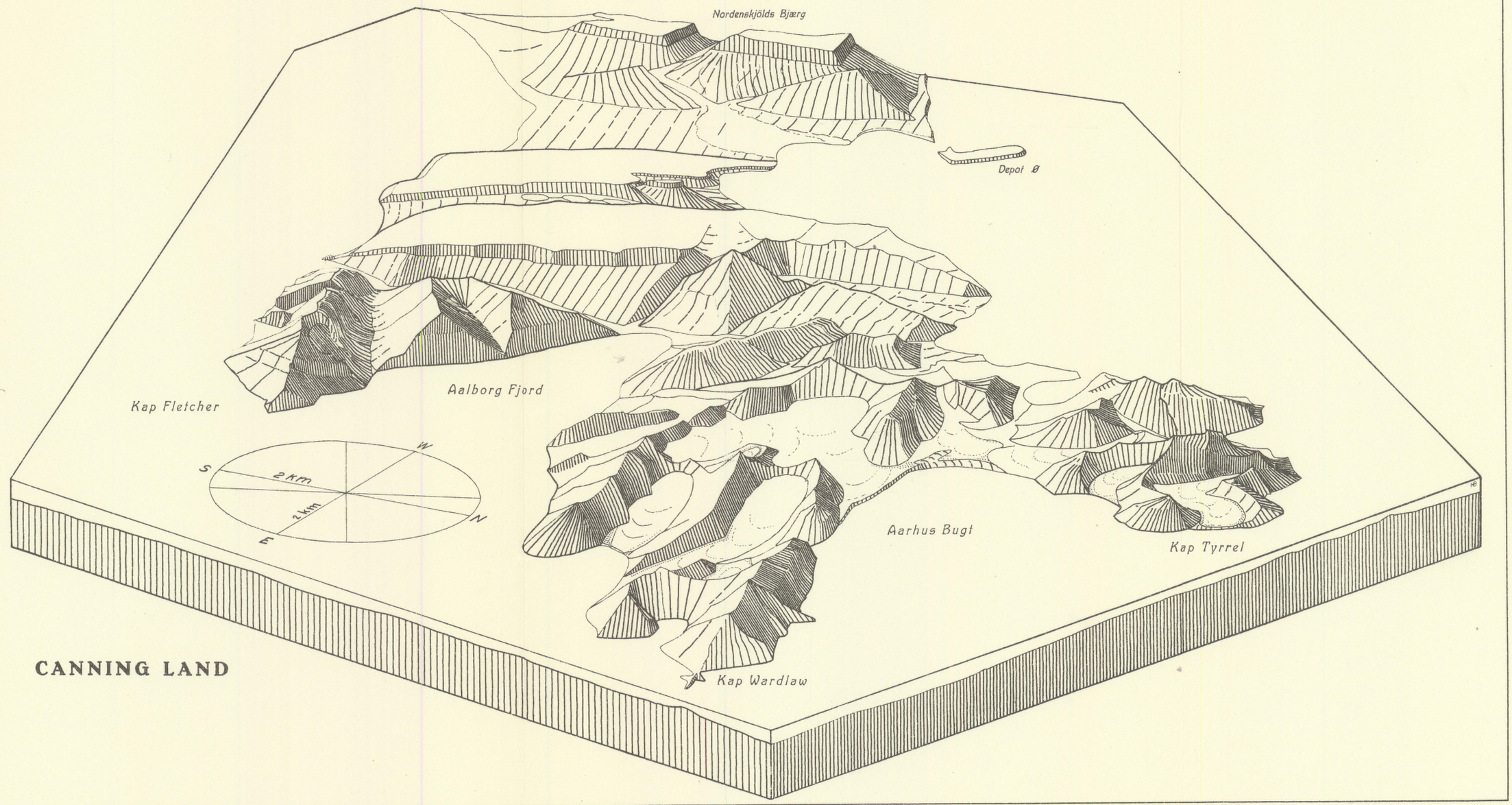


Plate 2.

Stereographic representation of the topography of Canning Land.

Construction on the parallel perspective, direction of view approximately WSW, angle of inclination 22°.



CANNING LAND

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Plate 3.

Geologic-tectonic sketch map of the area of Kejser Franz Josephs Fjord and Kong Oscars Fjord, compiled from the author's own observations and the maps by MITTELHOLZER, NOE-NYGAARD, SÄVE-SÖDERBERGH, SCHAUB, STAUBER, TEICHERT, VISCHER, and WEGMANN.

Legend:

1) Caledonian crystalline rocks of the inner fjord zone.
2) Caledonian crystalline rocks of the Devonian zone of folding.
3) Caledonian crystalline rocks of the uplifted margins of the blocks in the outer fjord zone.
4) Non-metamorphic Caledonian sediments (Eleonore Bay Formation and Cambro-Silurian).
5) Devonian formations (conglomerates, sandstones, and volcanic formations).
6) Continental Carboniferous (predominantly sandstones and conglomerates).
7) Post-Carboniferous deposits (Permian, Triassic, Jurassic, Cretaceous).
8) The most important faults within the outer zone. Assumed faults indicated by broken lines.
9) Thrusts within the Devonian folding zone.
10) Distribution of Devonian volcanic formations.
11) Main area of distribution of acid Cretaceous-Tertiary eruptives (alkali-syenite group).

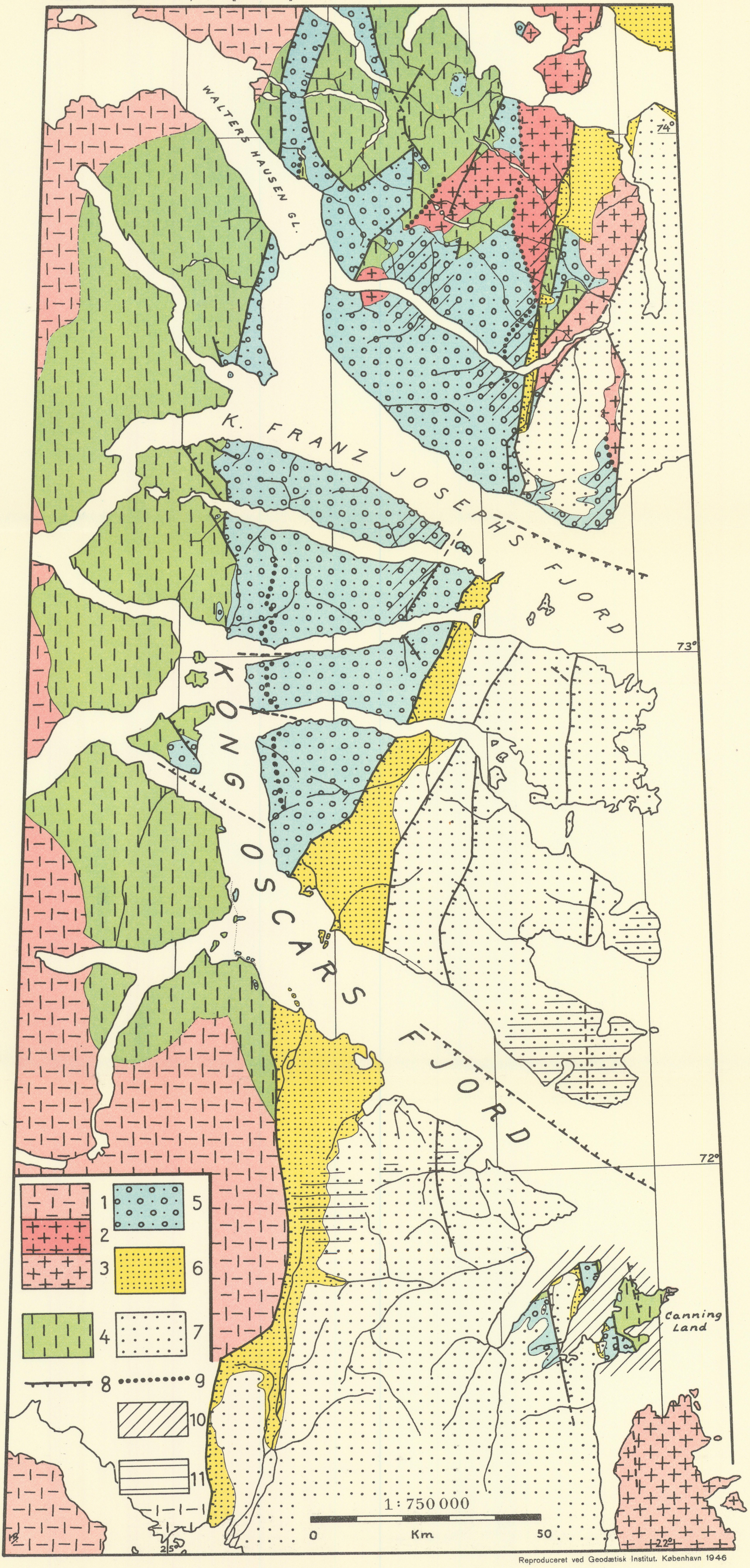

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Plate 4.

Geological map of Canning Land and the eastern part of Wegener Halvø.

The symbols for the dykes of the volcanic Kap Fletcher Series and the Late-Caledonian granites indicate only the areas in which these rocks are present.

Correction to Legend:
For *Quartzitic schists* read: *Quartzitic slates and shales*.

Fleming Fjord

Kap Brown

Kap Tyrrel

Snevigen

Aarhus Bugt

Kap Wardlaw

Nathorst Fjord

Doubletvigen

Depot Ø

Aalborg Fjord

Kap Fletcher

1 : 75 000

0 Km 10

N

S

Quaternary
Glaciers, Terraces, Diluvium and Alluvium

Trias

Marine Permian (Zechstein)

Continental Carboniferous

Middle Devonian

Dykes of the volcanic Kap Fletcher Series

Kap Fletcher Series

Middle Eleonore Bay Formation, predominantly limestones and dolomites

Middle Eleonore Bay Formation, predominantly multicoloured shales

Lower Eleonore Bay Formation, dark quartzitic shales

Late Caledonian granitic dykes

Late Caledonian granite from Kap Wardlaw

Faults

Faults, assumed

Thrust-planes

Grey dykes

Basalt dykes

Geological Map of Canning Land and the Eastern Part of Wegener Halvø

The western regions partly compiled from the map by G. Säve-Söderbergh (1937)
by
Heinrich Bütler

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Plate 5.

Stereographic representation of the geology of Canning Land.

The topographic stereogram (Pl. 2) was used as a basis. In the sections the minor blocks have been somewhat removed from each other.

Legend: See the geological map, pl. 4. In the sections stronger colours are used.

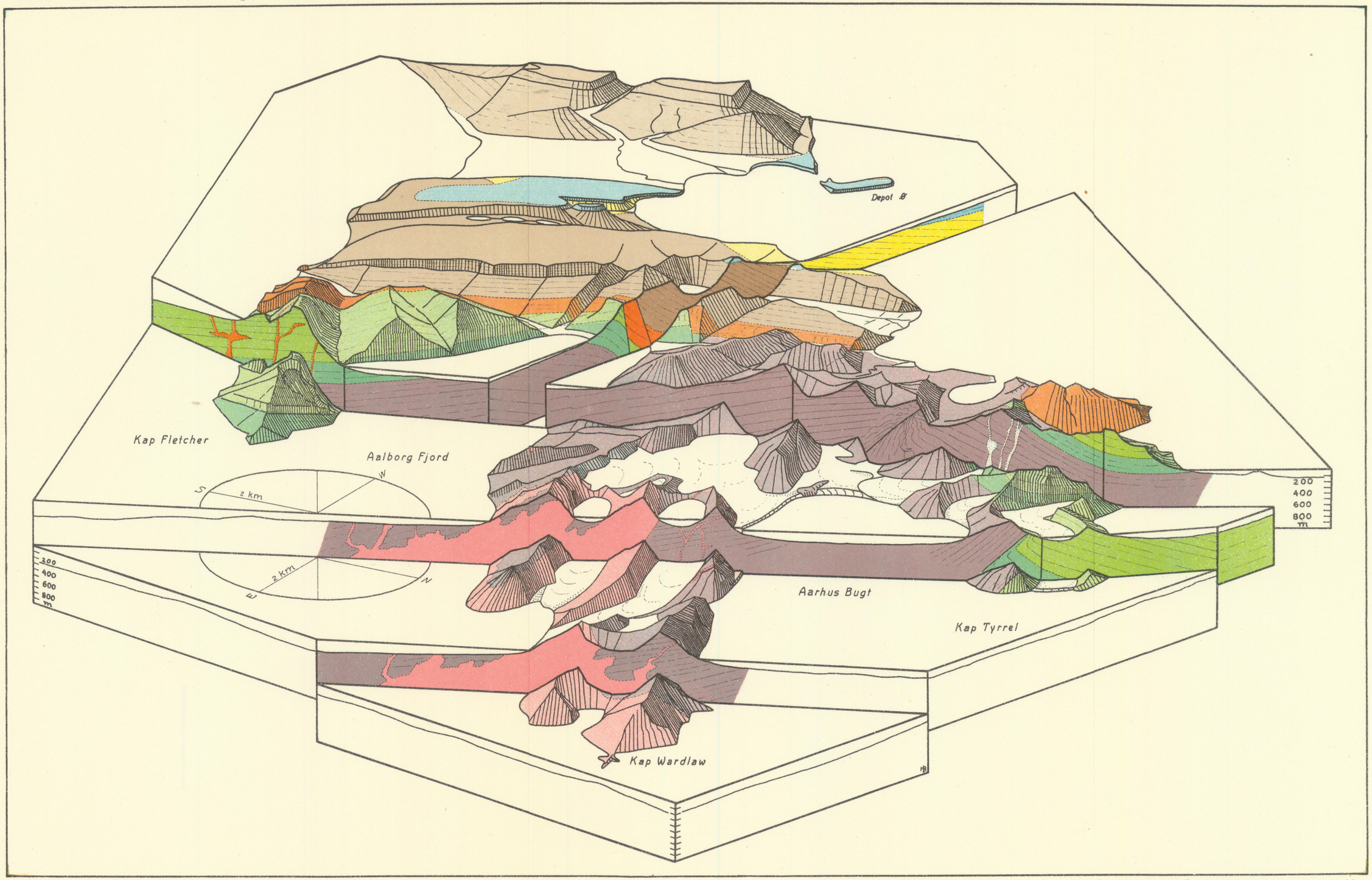


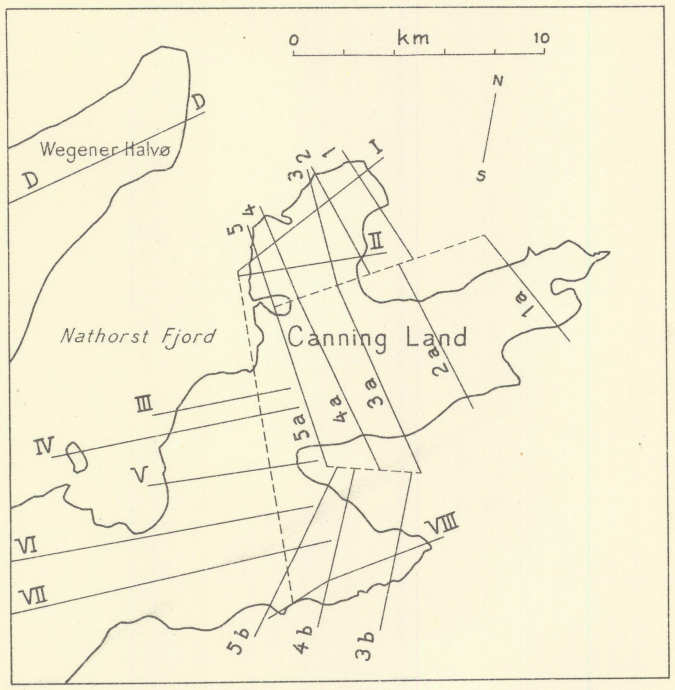
Plate 6.

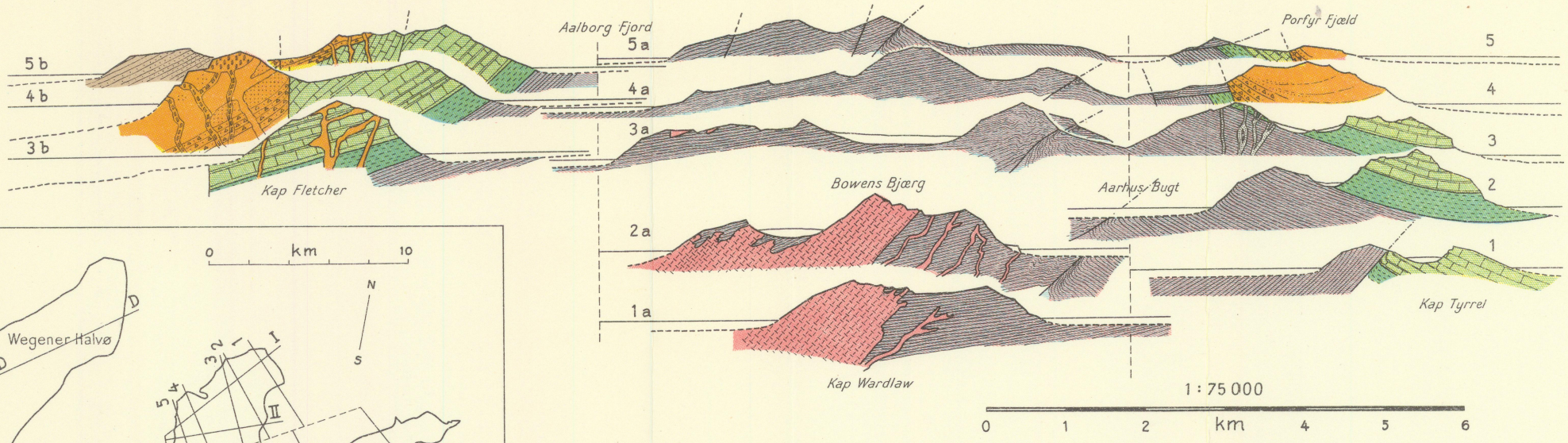
Geologic sections through Canning Land and Wegener Halvø.

The map of the coast contours shows the course and numbers of the sections. D—D: longitudinal section through Wegener Halvø.

Legend:
1) Caledonian crystalline rocks.
2) Eleonore Bay Formation.
3) Volcanic Kap Fletcher Series.
4) Middle Devonian.
5) Upper Devonian.
6) Continental Carboniferous.
7) Permian (Zechstein).
8) Trias.
9) Dykes of acid eruptives.
10) Basalt dykes.
11) Faults.
12) Upthrusts.

The dykes in the areas of Bowens Bjærg and the Kap Fletcher peninsula are only indicated approximately (cf. sections 2 a, 3 b, 4 b and VIII).





1 : 75 000

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